Received: 5 December 2023 | Accepted: 27 June 2024

DOI: 10.1111/resp.14793

CLINICAL PRACTICE GUIDELINE

Official Journal of the Asian Pacific Society of Respirology
Respirology
APSR
WILEY

Thoracic Society of Australia and New Zealand clinical practice guideline on adult home oxygen therapy

Christine F. McDonald[1,2,3] | **John Serginson**[4,5] | **Saad AlShareef**[6] | **Catherine Buchan**[7,8] | **Huw Davies**[9] | **Belinda R. Miller**[8,10] | **Maitri Munsif**[1,2,3] | **Natasha Smallwood**[7,8] | **Lauren Troy**[11,12,13] | **Yet Hong Khor**[1,2,3,7]

[1]Department of Respiratory and Sleep Medicine, Austin Health, Heidelberg, Victoria, Australia

[2]Institute for Breathing and Sleep, Heidelberg, Victoria, Australia

[3]Faculty of Medicine, University of Melbourne, Melbourne, Victoria, Australia

[4]Department of Respiratory Medicine, Sunshine Coast Health, Birtinya, Queensland, Australia

[5]School of Nursing, Midwifery & Social Work, University of Queensland, St Lucia, Queensland, Australia

[6]Department of Medicine, College of Medicine, Imam Mohammad Ibn Saud Islamic University (IMSIU), Riyadh, Saudi Arabia

[7]Respiratory Research@Alfred, Central Clinical School, Monash University, Melbourne, Victoria, Australia

[8]Department of Respiratory Medicine, Alfred Health, Melbourne, Victoria, Australia

[9]Respiratory and Sleep Services, Flinders Medical Centre, Southern Adelaide Local Health Network, South Australia, Australia

[10]Central Clinical School, Monash University, Melbourne, Victoria, Australia

[11]Department of Respiratory and Sleep Medicine, Royal Prince Alfred Hospital, Camperdown, New South Wales, Australia

[12]Sydney Medical School, Faculty of Medicine and Health, University of Sydney, Sydney, New South Wales, Australia

[13]Institute for Academic Medicine, Royal Prince Alfred Hospital, Camperdown, New South Wales, Australia

Correspondence
Christine F. McDonald
cmcdo@unimelb.edu.au

Handling Editors: Philip Bardin and Paul Reynolds

Abstract

This Thoracic Society of Australia and New Zealand Guideline on the provision of home oxygen therapy in adults updates a previous Guideline from 2015. The Guideline is based upon a systematic review and meta-analysis of literature to September 2022 and the strength of recommendations is based on GRADE methodology. Long-term oxygen therapy (LTOT) is recommended for its mortality benefit for patients with COPD and other chronic respiratory diseases who have consistent evidence of significant hypoxaemia at rest (PaO2 ≤ 55 mm Hg or PaO2 ≤59 mm Hg in the presence of hypoxaemic sequalae) while in a stable state. Evidence does not support the use of LTOT for patients with COPD who have moderate hypoxaemia or isolated nocturnal hypoxaemia. In the absence of hypoxaemia, there is no evidence that oxygen provides greater palliation of breathlessness than air. Evidence does not support the use of supplemental oxygen therapy during pulmonary rehabilitation in those with COPD and exertional desaturation but normal resting arterial blood gases. Both positive and negative effects of LTOT have been described, including on quality of life. Education about how and when to use oxygen therapy in order to maximize its benefits, including the use of different delivery devices, expectations and limitations of therapy and information about hazards and risks associated with its use are key when embarking upon this treatment.

KEYWORDS
clinical respiratory medicine, hypoxaemia, long-term oxygen therapy, oxygen guideline, oxygen therapy

INTRODUCTION

This Thoracic Society of Australia and New Zealand (TSANZ) Clinical Practice Guideline updates previous evidence-based guidance published by the Society on the use of domiciliary oxygen therapy for adults in the community.[1] The Guideline is intended for use by health care professionals, as well as government agencies and other providers of domiciliary oxygen therapy.

The Guideline includes broad recommendations for the use of domiciliary oxygen therapy, including: long-term continuous oxygen therapy, nocturnal oxygen therapy, ambulatory oxygen therapy, palliative oxygen therapy, short-term oxygen therapy and oxygen for specific indications, including during pulmonary rehabilitation, air travel, acute asthma and other.

The Guideline also reviews the evidence base for guidance on different oxygen delivery devices, considerations of safety and risks associated with using domiciliary oxygen therapy, initial assessment and follow-up of domiciliary oxygen therapy and education provision.

METHODS

Working Party formation

Following a call for expressions of interest, a multidisciplinary and geographically diverse group of TSANZ members was appointed to the Working Party including adult respiratory and sleep physicians, a respiratory and sleep nurse consultant, a respiratory nurse practitioner and a methodologist, with contributions during the early phase of development from a physiotherapist and an additional adult respiratory and sleep physician (see Table S1 in the Supporting Information for membership details).

Literature review

Key topic areas were identified by the Working Party to define the scope and priorities of the Guideline (Table S2 in the Supporting Information). A literature search was conducted using Ovid MEDLINE, EMBASE, CINAHL, Cochrane Database of Systematic Reviews and Cochrane Central Register of Controlled Trials, from inception. The initial search was conducted in February 2021 and updated in September 2022. For the full search strategies and results, see Table S3 and Figure S1 in the Supporting Information, respectively.

Inclusion and exclusion criteria for study selection are listed in Table S4 in the Supporting Information. Briefly, only original English language research articles were included. All working party members were involved in the literature appraisal. Sequential review of titles and abstracts followed by full-text articles was performed by two members independently to identify eligible citations. Data extraction was performed by one member using a standardized data extraction form, which was verified by a second member.

Evidence synthesis and appraisal

Existing data from relevant guidelines and systematic reviews of long-term oxygen therapy (LTOT) and ambulatory oxygen therapy were reviewed, checked and incorporated into the evidence synthesis with additional studies identified from the literature search. Meta-analyses using random-effects models were performed for nocturnal oxygen therapy using Review Manager (RevMan, version 5.4; the Cochrane Collaboration), as this had not been performed in previous guidelines and systematic reviews. Narrative synthesis of identified literature was performed for the remaining sections.

Risk-of-bias assessment of all included studies was evaluated independently by two members using risk assessment tools according to the Cochrane Handbook for Systematic Reviews of Interventions for randomized and non-randomized intervention trials and the Newcastle-Ottawa scale for observational studies. Disagreements were resolved by a third member if required. For grading of recommendations regarding different types of oxygen therapy the GRADE approach was adopted with consideration of study design, imprecision, indirectness, inconsistency, publication bias, risk of bias and other aspects (effect magnitude, dose–response gradients and confounders biasing toward an opposite effect). The strength of recommendations was graded as strong and weak based on consensus discussion, with the level of evidence being classified as high, moderate, low and very low.[2] Recommendations concerning oxygen delivery devices, safety considerations when using domiciliary oxygen therapy, initial assessment, education provision and follow-up of patients receiving domiciliary oxygen therapy were developed based on consensus discussion following literature review.

Peer review and dissemination

This Guideline underwent joint peer review by TSANZ and Respirology and will be reviewed by TSANZ for currency within 36–48 months. Once published, this Guideline is intended for dissemination through the TSANZ website and educational program.

LONG-TERM CONTINUOUS OXYGEN THERAPY

Chronic obstructive pulmonary disease

a. Severe resting hypoxaemia

There have not been any high-quality randomized controlled trials (RCTs) of LTOT for severe resting hypoxaemia since the landmark Nocturnal Oxygen Therapy Trial (NOTT) and Medical Research Council (MRC) trial were

reported in the 1980s (Table S5 in the Supporting Information). Criteria for entry to the NOTT were PaO2 ≤55 mm Hg with or without hypercapnia or PaO2 ≤59 mm Hg in the presence of cor pulmonale, haematocrit ≥55% or electrocardiographic evidence of P pulmonale on two measurements over a 3-week exacerbation free period.[3] The trial enrolled 203 patients with stable hypoxaemia who were randomized to nocturnal or continuous oxygen therapy (concentrator plus portable oxygen) with follow-up for 3 years or until death. Overall mortality in the nocturnal group was significantly higher at 1.94 times that in the continuous oxygen therapy group, with the latter averaging 18 h of oxygen usage per 24 h. The MRC trial included 87 hypercapnic patients with COPD and PaO2 40–60 mm Hg on two measurements over a 3-week exacerbation-free observation period.[4] In this unblinded study, patients received oxygen via concentrator for 15 h/day (without portable oxygen) or no oxygen at all. Patients were followed for 5 years or until death. Nineteen of the 43 treated patients died during follow-up compared with 30 out of 45 controls.[4] There have been no head-to-head studies examining what the appropriate duration of continuous oxygen therapy should be. In a prospective Swedish cohort study of 2249 patients with COPD, no mortality difference was observed between patients who were prescribed oxygen for 24 h or 15 h per day.[5]

Few studies have evaluated the impact of LTOT on hospitalization. In an Egyptian observational study, LTOT following hospital discharge after exacerbation of COPD reduced hospitalizations and improved health-related quality of life (HRQoL),[6] while in an Australian study, bed days per patient year of follow-up of a cohort of patients with chronic airflow limitation were reduced by 35% after the introduction of LTOT.[7] In a retrospective Swedish study there was no difference in hospitalization between the two durations of therapy—15 h versus 24 h.[8]

Evidence regarding other treatment effects of LTOT in patients with COPD remains limited. Although modest and comparable improvements in neuropsychological tests compared to baseline were demonstrated after 6 months of either continuous or nocturnal oxygen therapy in a subset of the NOTT, no appreciable changes were found in self-reported general emotional status or HRQoL.[9] Similarly, no HRQoL effect of LTOT was found after 6 months of LTOT in a United Kingdom (UK) study.[10] In a New Zealand study of two groups of patients with COPD, one fulfilling criteria for and started on LTOT (as per the NOTT study[3]) and the second not fulfilling criteria and continuing with usual care, HRQoL was worse at baseline in the LTOT group and showed significant improvements at 2 and 6 months, while the non-LTOT group showed a progressive decline.[11]

b. Moderate resting hypoxaemia

Benefits of LTOT in patients with COPD and moderate resting hypoxaemia remain unproven, where varying definitions of 'moderate' are used in this context (Table S6 in the Supporting Information). A Polish study of 135 patients with COPD and resting PaO2 56–65 mm Hg, randomly assigned to LTOT 17 h/day versus no LTOT found no difference in cumulative survival,[12] and no reduction in hospitalizations was found in a Danish study comparing pre- and post-oxygen hospitalizations after at least 1 month of continuous oxygen therapy in patients with PaO2 55–71 mm Hg.[13] Similar results to these two earlier studies were found in the long-term oxygen treatment trial (LOTT) where 738 patients with COPD and resting SpO2 89%–93% were randomized to continuous oxygen or no oxygen.[14] Initial recruitment was slow and entry criteria were expanded to also include patients who desaturated only during exercise. Treatments included oxygen 24 h per day (via stationary and portable devices) for moderate resting hypoxaemia and nocturnal and exertional oxygen in the case of exercise desaturation only. No differences between groups were found for the primary composite outcome of death or hospitalization for COPD or for any secondary outcome.

Other chronic respiratory and cardiac diseases

There are limited published clinical trials evaluating treatment effects of LTOT beyond patients with COPD (Table S7 in the Supporting Information), which are summarized below.

a. Heart failure

In a UK RCT, 139 patients with heart failure and New York Heart Association (NYHA) class III/IV symptoms were randomized to receive 6 months of LTOT 15 h/day versus no treatment.[15] No benefit was observed in any outcome measure at 6 months, although the Minnesota Living with Heart Failure score was lower at 3 months in the LTOT group.

b. Chronic thromboembolic pulmonary hypertension (CTEPH)

In a crossover study of 30 patients with CTEPH and exertional desaturation without resting hypoxaemia randomized to oxygen >16 h/day via concentrator (mean usage 13.2 h/day) or identical concentrator modified to provide 21% oxygen over 5 weeks, there was a statistically significant improvement of 19 m in 6-min walk distance on room air (although this was less than the minimal important difference), compared with −1 m for the placebo air group.[16] There were improvements in HRQoL with between-group difference of 6 points for SF-36 physical functioning and NYHA functional class, compared with air.

c. Kyphoscoliosis

In a prospective observational study of 244 patients with respiratory failure due to kyphoscoliosis, LTOT was inferior to mechanical ventilation at home for survival.[17]

Recommendations for LTOT.
Unchanged from previous Guideline.

- Long-term continuous oxygen therapy aimed at improving survival is recommended for suitable patients with awake resting PaO_2 on room air consistently ≤55 mm Hg, or PaO_2 ≤ 59 mm Hg in the presence of cor pulmonale, haematocrit ≥55% or ECG evidence of P pulmonale during an exacerbation free period who have
  - COPD, (Strength of recommendation: Strong; Evidence: Moderate)
  - other conditions, including but not limited to chronic respiratory or cardiac diseases (Strength of recommendation: Strong; Evidence: Low)
- Safety considerations should be included in patient-centric discussions of LTOT initiation, including both physical and psychological impacts (Tables S5–S7 in the Supporting Information and see 'Safety considerations' section)

Changed from previous Guideline-new recommendation.

- Long-term continuous oxygen therapy is not recommended for patients with COPD and moderate resting hypoxaemia (i.e., PaO_2 56–59 mm Hg in the absence of cor pulmonale, haematocrit ≥55% or ECG evidence of p pulmonale) (Strength of recommendation: Strong; Evidence: Low). Extrapolating from this, and in the absence of evidence, long-term continuous oxygen is not recommended for patients with moderate hypoxaemia due to other conditions

NOCTURNAL OXYGEN THERAPY

Nocturnal hypoxaemia may occur in the absence of daytime hypoxaemia in patients with chronic respiratory and cardiac diseases, with or without associated sleep disordered breathing. Nocturnal hypoxaemia has been linked with poorer prognosis, disease progression and development of pulmonary hypertension in patients with COPD, interstitial lung disease (ILD) and cystic fibrosis (CF).[18–21]

Chronic obstructive pulmonary disease

Three RCTs including a total of 183 patients with COPD and isolated nocturnal hypoxaemia investigated the impact of nocturnal oxygen therapy (NOT) on survival and progression to LTOT,[22–24] including the International Nocturnal Oxygen trial (INOX). Meta-analyses of these studies showed no impact of nocturnal oxygen therapy on 3-year survival and/or progression to LTOT (Figure S2 in the Supporting Information), with a similar absence of effects observed for secondary endpoints in the INOX trial including hospitalizations, acute exacerbation rates or HRQoL.[22] Conflicting results were reported regarding the impact of NOT on invasively measured pulmonary haemodynamics in the two smaller studies.[23,24]

Several small crossover studies of NOT versus room air in patients with COPD and varying degrees of nocturnal oxygen desaturation failed to demonstrate any benefit with respect to sleep quality or daytime exercise performance (Table S8 in the Supporting Information). A small study comparing nasal continuous positive airway pressure (CPAP) with entrained oxygen at 1.5 L/min against CPAP and room air on three single overnight studies in 10 hypoxaemic male patients with COPD-OSA overlap showed improved oxygenation and abolition of obstructive events with the combination intervention of CPAP and oxygen, compared with CPAP and room air.[25]

Heart failure

Multiple short- and long-term studies have compared NOT with different controls (medical air, room air, or no treatment) in patients with heart failure and associated Cheyne Stokes respiration (Table S9 in the Supporting Information). Two RCTs of NOT versus air for 6–12 months in patients with heart failure demonstrated consistent improvements in indices of sleep disordered breathing, but conflicting impacts on HRQoL, functional status and left ventricular ejection fraction.[26,27] Similar benefits in sleep indices were observed in a meta-analysis of two RCTs including a total of 76 patients assigned to NOT or room air during sleep over 12 weeks (Figure S3 in the Supporting Information).[28,29] A follow-up survey sub-study of these Japanese studies reported economic benefits with NOT resulting in total medical cost-reduction, which was primarily related to reduced hospital bed-days.[30]

Findings from several small crossover, before-and-after and uncontrolled studies support the benefit of NOT over room air for treating obstructive and central sleep apnoea, with variable impact on HRQoL measures, cognition, cardiac function and daytime exercise performance (Table S9 in the Supporting Information). In-laboratory single-night studies also consistently show an improvement in mean sleep oxygenation, overall apnoea-hypopnoea index (AHI) and central AHI with NOT (Table S9 in the Supporting Information). Cardiac arrhythmias and heart rate variability were not attenuated with NOT compared with room air in these studies, however, heterogeneity in individual responsiveness has been observed.[31–33]

Nocturnal oxygen therapy has also been evaluated against CPAP and adaptive servoventilation (ASV) in two

studies of patients with heart failure. With small sample sizes and limited intervention periods of 12 weeks, neither study demonstrated clear superiority for either intervention with respect to indirect measures of right ventricular strain, pulmonary haemodynamics or exercise capacity, although there was a greater reduction in AHI with CPAP or ASV than with NOT.[34,35]

Obstructive sleep apnoea

Uncomplicated obstructive sleep apnoea (OSA) is typically managed with risk factor mitigation, and CPAP therapy. Alternative therapeutic strategies including NOT have been studied (Table S10 in the Supporting Information). One large RCT evaluated CPAP versus NOT at 2 L/min versus education only in an OSA population with cardiovascular disease or multiple cardiac risk factors over 12 weeks.[36,37] This study demonstrated reduced blood pressure and improvements in sleepiness, mental health, social functioning and depressive symptoms in the CPAP group, but no impact with lifestyle education alone or NOT.[36,37] Physical function as assessed by the SF-36 questionnaire, however, was superior in the NOT group, compared with the CPAP group. Short-term studies comparing NOT with CPAP in patients with OSA have generally confirmed superiority of CPAP over NOT for sleep quality, neuropsychological and cardiovascular endpoints,[38–40] except for one reporting improved depression scores from baseline in subjects assigned to NOT but not in CPAP or sham CPAP groups.[41]

Other chronic respiratory diseases

There are limited published clinical trials evaluating treatment effects of NOT in patients with CF and ILD (Table S11 in the Supporting Information).

a. Cystic fibrosis

Small studies of single-night NOT in adults with CF and isolated nocturnal hypoxaemia suggested a modest improvement in oxygenation compared with room air, however, with consequent elevations in transcutaneous CO2 levels.[42–44] In an Australian RCT of non-invasive ventilation (NIV) with or without entrained oxygen versus low-flow NOT alone over 12 months in patients with nocturnal hypoxaemia[45] those receiving NIV with or without oxygen had a greater event-free survival compared with the NOT group, with events defined as worsening hypercapnia, death or lung transplantation.

b. Interstitial lung disease

While a recent Delphi survey of international ILD experts supported the use of NOT in patients with ILD with isolated nocturnal hypoxaemia,[46] there has only been one published paper evaluating this therapy.[47] In this case–controlled study over two nights at 2240 m altitude, 19 patients who received oxygen during sleep had improved mean SpO2 and reduced heart and respiratory rates during sleep, compared to those on room air.

Recommendations for NOT.

Major changes from previous Guideline.

The previous Guideline recommended NOT for a subgroup of patients with lung disease and associated sleep-related hypoxaemia (desaturating to ≤88% for more than a third of total sleep time) but without severe daytime hypoxaemia, in particular for those with evidence of hypoxic sequelae such as pulmonary hypertension and polycythaemia, based on weak evidence.[1] This recommendation has been updated based on recent literature as follows:

- Nocturnal oxygen therapy is not recommended for nocturnal hypoxaemia in the absence of daytime hypoxaemia and/or sleep disordered breathing in patients who have:
  - COPD, (Strength of recommendation: Weak; Evidence: Low)
  - other chronic respiratory conditions (Strength of recommendation: Weak; Evidence: Very low)
- Nocturnal oxygen therapy is recommended as second-line treatment for patients with chronic heart failure and persistent Cheyne Stokes respiration after medical optimisation and consideration of CPAP as a treatment option (Strength of recommendation: Strong; Evidence: Moderate)
- Nocturnal oxygen therapy is not recommended as first-line treatment for patients with OSA (Strength of recommendation: Strong; Evidence: Moderate) although it may be considered in those who are intolerant of CPAP (Strength of recommendation: Weak; Evidence: Very low).

AMBULATORY OXYGEN THERAPY

Ambulatory oxygen therapy can be used as either a component of LTOT for patients with resting hypoxaemia or in isolation for patients with exertional hypoxaemia without resting hypoxaemia where benefit in terms

of exercise capacity or dyspnoea is demonstrated. Across cohorts of patients with isolated exertional hypoxaemia, however, evidence for preferred laboratory-based testing modalities, thresholds for clinical response and evidence for long-term therapeutic benefit based upon in-laboratory assessments is limited.

Chronic obstructive pulmonary disease

There have been no RCTs evaluating ambulatory oxygen therapy in patients with COPD since the last TSANZ Guideline (Tables S12 and S13 in the Supporting Information). For patients with resting hypoxaemia needing LTOT, provision of ambulatory oxygen therapy in addition to a stationary oxygen concentrator may assist with achieving a longer duration of oxygen treatment in order to maximize the benefits of LTOT.[3] For patients with isolated exertional hypoxaemia or without evidence of resting or exertional hypoxaemia, while acute benefits including improved oxygenation, exercise capacity (frequently measured as 6-min walk distance) and dyspnoea have been demonstrated in some studies of supplemental oxygen during in-laboratory exercise tests, there is no evidence suggestive of short-term or long-term effects on symptoms, HRQoL, healthcare utilization or survival for ambulatory oxygen therapy. A recent retrospective observational study of 174 patients with isolated exertional desaturation showed no difference in survival over a median of 55 months between patients with or without improved 6-min walk distance using ambulatory oxygen therapy.[48]

Interstitial lung disease

No studies evaluated effects of LTOT or ambulatory oxygen therapy in patients with ILD and chronic resting hypoxaemia. For patients with isolated exertional hypoxaemia, an unblinded crossover study of 2 weeks of ambulatory oxygen therapy in 84 patients showed improved HRQoL, compared to no treatment.[49] As in similar studies of patients with COPD, acute benefits of improved exercise capacity were observed with supplemental oxygen during in-laboratory exercise tests, without consistent changes in dyspnoea scores (Table S14 in the Supporting Information).

Other chronic respiratory and cardiac diseases

There are limited in-laboratory studies of supplemental oxygen during exercise tests in patients with other chronic respiratory diseases and cardiac diseases, demonstrating inconsistent effects on symptoms and exercise capacity (Table S15 in the Supporting Information).

Recommendations for ambulatory oxygen therapy.
Unchanged from previous Guideline.

- Ambulatory oxygen therapy is recommended to maximize the benefits of LTOT in those fulfilling criteria for LTOT. (Strength of recommendation: Strong; Evidence: Low)
- Ambulatory oxygen therapy may be recommended for suitable patients with lung diseases without severe resting hypoxaemia and during an exacerbation-free period, who have exertional hypoxaemia (desaturation to ≤88% during exercise tests such as the 6-min walk test [6MWT]) where improvement is demonstrated in exercise capacity or level of dyspnoea. (Strength of recommendation: Weak; Evidence: Low).
- While the use of ambulatory oxygen therapy may allow outdoor access and encourage physical activities, it is associated with physical challenges due to equipment weight and non-ergonomic design, as well as psychosocial stresses (Table S16 in the Supporting Information and see 'Safety considerations' section). Adequate education and discussion with patients and their caregivers are needed to support treatment decision-making for the prescription and use of ambulatory oxygen therapy.

PALLIATIVE OXYGEN THERAPY

Palliative oxygen therapy refers to domiciliary oxygen therapy prescribed for the relief of dyspnoea in patients with life-limiting illness who may not have hypoxaemia.

In five of six studies, including one multicentre international RCT of 239 patients,[50] palliative oxygen therapy showed no significant difference in reduction of dyspnoea compared to either medical air or no control (Table S17 in the Supporting Information).[50–54] The studied populations and settings included patients with and without hypoxaemia, and with malignant and non-malignant illnesses, who were evaluated for domiciliary or inpatient usage, as well as during in-laboratory assessments. In the large RCT of stable patients with life-limiting illness and severe dyspnoea, no differences were found in HRQoL or sleep parameters between oxygen and air at 2 L/min via stationary concentrators for at least 15 h per day for 7 days.[50] A retrospective cohort study showed that domiciliary oxygen therapy was not significantly associated with survival in patients with advanced cancer and low oxygen saturation.[55]

Although there is no high-quality evidence demonstrating that palliative oxygen therapy reduces dyspnoea, some patients do appear to derive benefit from oxygen therapy. In one pre- and post-study of patients referred to palliative care, which showed no significant difference in mean dyspnoea after 1–2 weeks of domiciliary oxygen therapy, a subset of 150 patients amongst 413 showed 20% or greater improvements in dyspnoea score.[54]

However, no underlying diagnostic or demographic factors could be identified as predicting responders at 1 week.[54]

Caregivers for people receiving domiciliary oxygen therapy for refractory dyspnoea in a palliative setting reported conflicting feelings. Many felt extreme distress at witnessing refractory dyspnoea and felt oxygen fulfilled critical and beneficial roles in this context, but also reported burden in loss of patient autonomy and cost.[56] Clinicians similarly report mixed opinions on the role of palliative oxygen therapy to treat dyspnoea.[57–59] In a randomized crossover laboratory study of 51 patients with advanced cancer and dyspnoea, there was no difference in patient preference for medical air or oxygen therapy.[52]

Recommendations for palliative oxygen therapy.
Minor changes from previous Guideline.
Palliative oxygen therapy is not recommended to treat patients with severe dyspnoea and a life-limiting illness who do not have severe resting hypoxaemia. (Strength of recommendation: Strong; Evidence: Low).

SHORT-TERM OXYGEN THERAPY

The provision of domiciliary oxygen to patients who remain significantly hypoxaemic, typically at rest, upon hospital discharge, has been termed short-term oxygen therapy (STOT). The rationale for STOT provision lies in the concern that ongoing hypoxaemia may have adverse outcomes. There is a paucity of studies to support its use (Table S18 in the Supporting Information) and potential adverse effects include risk of worsened underlying hypercapnia in the setting of unstable respiratory disease, patient safety and risk considerations such as fire and burns (described later), as well as increased healthcare costs. Nevertheless, hypoxaemia and the requirement for domiciliary oxygen therapy at discharge have been reported as independent predictors of long-term mortality in patients hospitalized for acute exacerbation of COPD.[60]

More recently, STOT has been used to facilitate early discharge and outpatient management of patients with COVID-19 pneumonia at times of scarce hospital resources, which is not covered in this Guideline.[61]

Prescribing eligibility and reassessment for STOT

Eligibility criteria for STOT are not standardized and thus are likely to vary across health services. Reported criteria for STOT provision are often derived directly from those used to assess eligibility for LTOT for severe resting hypoxaemia, using arterial blood gas measurements of PaO_2 ≤55 mm Hg or 56–59 mm Hg with evidence of hypoxic end-organ damage.[62–66] There is no evidence of the benefits or otherwise of prescription of STOT for ambulation alone.

It is well-recognized that hypoxaemia may resolve after an acute illness, and that unnecessary ongoing oxygen use incurs significant resource costs and potential patient adverse events. Previous studies reported that 40%–80% of patients on STOT did not meet criteria for LTOT at subsequent assessment at a range of 30–90 days post hospital discharge.[62–64,66–68] Additionally, appropriate reassessment for eligibility for LTOT occurred in only 43%–62% of patients discharged on STOT.[64,66,67] Different societies and expert groups consistently recommend reassessment of oxygenation status within 90 days of hospital discharge,[69,70] pending further studies. Predictors of progression of patients to LTOT from STOT have not been well identified.[64,65]

Recommendations for STOT.
New recommendations.
There is a paucity of evidence-based data to guide decision-making with respect to STOT. However, ongoing provision of STOT may be justified if the benefits of alleviating hypoxaemia in an individual patient are deemed to outweigh the potential risks of domiciliary oxygen therapy.

- Short-term oxygen therapy may be recommended for patients with persistent severe resting hypoxaemia at hospital discharge. The use of LTOT prescribing criteria in the assessment for STOT is recommended as a pragmatic approach. (Strength of recommendation: Weak; Evidence: Very low)
- Reassessment for oxygen requirement should be conducted between 30 and 90 days post discharge and when stable. (Strength of recommendation: Strong; Evidence: Very low)
- Education regarding oxygen therapy should be provided to patients and their caregivers prior to discharge, including realistic expectations of its effects. In addition, patients and their caregivers should be informed of the need for reassessment

of oxygenation status post discharge and the potential withdrawal of oxygen therapy if no longer indicated.

SPECIFIC INDICATIONS: EXERCISE TRAINING, AIR TRAVEL, ACUTE ASTHMA, HEADACHE

Exercise training

The effects of supplemental oxygen during exercise training have been primarily studied in patients with COPD (Table S19 in the Supporting Information). Since the last TSANZ guideline, a multicentre RCT demonstrated improved exercise endurance and HRQoL after 24 sessions of exercise training over 8 weeks with oxygen or air delivered at 5 L/min in 111 patients with COPD and exertional desaturation, with no between-group differences identified.[71] Similar findings were observed in a number of small RCTs with moderate-to-high risk of bias in patients with COPD who had varying oxygen requirements[72–77] while one small study that included patients with chronic respiratory failure from a range of causes on LTOT demonstrated greater improvement in 6MWD following pulmonary rehabilitation with heated, humidified nasal high flow oxygen (hNHF-O_2) compared with oxygen via standard nasal cannula at 6 L/min.[78] Of note, there may be benefits of exercise training with supplemental oxygen in a selected population of patients with COPD, exertional desaturation and positive acute response to supplemental oxygen during exercise tests.[79] This warrants further evaluation.

Recommendations for exercise training.
Major changes from previous Guideline.

- Supplemental oxygen is not recommended for exercise training in patients with COPD not fulfilling LTOT criteria. (Strength of recommendation: Strong; Evidence: Low).
- There are insufficient data to make recommendations regarding the use of oxygen for exercise training in other chronic respiratory conditions

Air travel

Cabin pressures of commercial passenger aircraft range up to 2500 m above sea level ambient pressures during standard operating conditions, which is analogous to breathing 15% oxygen at sea level.[1] A small number of studies have explored the impact of oxygen therapy on PaO_2 at high altitude in patients with chronic respiratory disease.[80–84] Most were experimental studies simulating a commercial aircraft cabin altitude of 8000 ft and administered supplemental oxygen via different delivery methods, including continuous flow via a nasal cannula, an oxygen-conserving device, portable oxygen concentrator (POC), or Venturi mask (Table S20 in the Supporting Information). Oxygen administration significantly increased PaO2 at altitude in some[80–82] but not all studies,[83] with results appearing to be affected by the oxygen delivery method. In a survey of patients using LTOT who had flown with supplemental oxygen,[84] the majority found it complicated their travel in terms of accessing required information and organization, although four-fifths stated they would fly again.

As a practical approach, individuals with resting oxygen saturation ≥95% are unlikely to require in-flight supplemental oxygen.[85,86] For other individuals, in-flight oxygen should be considered, particularly for those with previous significant intolerance to air travel, such as the requirement for mid-air emergency oxygen or diversion, or who are using LTOT. Of note, neither resting sea level oxygen saturation nor lung function reliably predicts hypoxaemia or complications of air travel in patients with respiratory disease.[86–88] A hypoxic challenge test, also known as an altitude simulation test, can be performed to provide a more accurate evaluation of altitude oxygenation and prescription of in-flight supplemental oxygen for maintaining PaO2 >50 mm Hg or oxygen saturation >85%, particularly in those with existing hypercapnia or at risk thereof.[85,89,90]

Recommendations for air travel.
Minor changes from previous Guideline.

- Consideration of supplemental oxygen during air travel is recommended, where a traveller fulfils criteria for requiring LTOT (without evidence of hypercapnia) or has a demonstrated fall in PaO2 to <50 mm Hg or SpO2 to <85% during a hypoxic challenge test. (Strength of recommendation: Strong; Evidence: Low).

Acute asthma

There is one prospective observational study showing that the availability of domiciliary oxygen for administration at the start of an asthma attack reduced the risk of death in individuals at high risk for recurrent life-threatening

asthmatic attacks (Table S20 in the Supporting Information).[91]

Recommendations for acute asthma.
Minor changes from previous Guideline.

- Domiciliary oxygen therapy for acute use while awaiting medical attention can be considered in patients with previous near-fatal asthmatic attacks, at high risk of a future fatal asthmatic attack, or in patients with episodic acute asthma living in isolated areas. (Strength of recommendation: Weak; Evidence: Very low)

Headache

Supplemental oxygen therapy has been studied for treatment of acute episodes of chronic headache (Table S20 in the Supporting Information). Inhaled oxygen at a flow rate of ≥10 L/min was found to be effective in treating acute attacks of cluster headache[92,93] and acute migraine[94] in randomized crossover trials, but not for medication overuse headache in a case series.[95]

Recommendations for headache.
Major changes from previous Guideline.

- Intermittent inhaled high-flow oxygen (100% at 10–15 L/min via a non-rebreather mask) can be offered to patients to treat acute cluster headache attacks and acute migraine. (Strength of recommendation: Strong; Evidence: Low).

DOMICILIARY OXYGEN DELIVERY

Oxygen therapy sources and equipment for improving the efficiency of oxygen use are key to domiciliary oxygen delivery. In recent years, domiciliary use of humidified nasal high-flow oxygen (hNHF-O_2) has been explored. While there has been interest in the development of novel devices for auto-titration,[96–100] remote control,[101] compliance monitoring,[102–104] and alternative sources of oxygen therapy,[105] they remain yet to be available for commercial use.

Sources of domiciliary oxygen delivery

Sources of domiciliary oxygen delivery can be divided into stationary and ambulatory (Table S21 in the Supporting Information). While liquid oxygen systems are used in some countries,[106–108] they are not available for domiciliary use in Australia and New Zealand.

Stationary oxygen source

Stationary oxygen concentrators remain the major source for providing LTOT within the home. They are floor-standing devices powered by the domestic electricity supply and provide an oxygen concentration of 90%–95%.[1] The maximum flow delivery of stationary oxygen concentrators is typically 5 L/min with some being capable of delivering up to 10 L/min, although the percentage of oxygen falls with increasing flow rate.[109,110] With the use of 9 m extension tubing, patients can move around the home, but it is important to note that increasing tubing length beyond 30 m can result in a fall in the concentration of delivered oxygen,[111,112] in addition to the potential hazard of tripping or falling. Performance of stationary oxygen concentrators can be affected by their working duration, with lower oxygen concentration associated with longer working duration,[110,113] indicating the importance of regular device checks and servicing.

Ambulatory oxygen source

In Australia and New Zealand, there are two sources for ambulatory oxygen, with compressed oxygen cylinders of varying sizes being the most common and POCs of different models being increasingly used in recent years. Compressed oxygen cylinders contain 100% pure oxygen delivered at flow rates ranging between 1 and 6 L/min, whereas POCs are rechargeable lightweight devices that generally deliver oxygen concentrations of ≥90% in pulsed doses and/or continuous flow. Of note, POCs offer a range of numbered flow settings that vary across models. These are not equivalent to the numbered flow rate for compressed oxygen cylinders (e.g., setting of 1 for POC is not equivalent to flow rate of 1 L/min for compressed oxygen cylinder). Different POC models vary in their weight and size, oxygen pulse delivery, battery life and performance at altitude (Table S21 in the Supporting Information).[114–117]

Studies comparing the performance of compressed oxygen cylinders and various POCs during in-laboratory assessments and short-term domiciliary use in patients with different respiratory diseases generally revealed similar dyspnoea scores, HRQoL, oxygenation capacity and 6-min walk distances between cylinders and POCs, although there were some between-study variations (Table S21 in the Supporting Information).[118–128] POCs are preferred over compressed oxygen cylinders for their portability and ease of use, although these factors may be of less concern for younger patients.[123,125,127,128] Of note, POCs have potential limitations with regard to battery life and oxygenation capacity, particularly for patients requiring high flow settings, given their lower oxygen concentration delivery. The transportability of the ambulatory oxygen source may affect

patients' exercise capacity and dyspnoea level, noting that carrying the device in a backpack may be favoured over using a trolley or shoulder strap.[129–131]

Efficient use of oxygen

Efficient oxygen use can be achieved by using oxygen conserving devices (OCDs), including demand oxygen delivery systems and specialized oxygen-conserving nasal cannulae. These devices allow breath-triggered oxygen pulse delivery early in inspiration to reduce gas wastage during expiration compared to continuous flow. The efficiency of maintaining adequate oxygenation at lower oxygen usage yields practical benefits, including extended cylinder range or the same range with smaller and lighter cylinders, resulting in reduced cumulative refilling costs. There have been few advances in this area since the last TSANZ Guideline (Table S22 in the Supporting Information).

The volume, delivery waveform and frequency vary across different OCD models, which are given as either a pre-set pulse volume (some or all breaths) or a pre-set minute volume averaged by respiratory rate that can affect oxygen delivery during exertion.[132] The specialized nasal cannula with a pendant-shaped reservoir allows its filling with oxygen during exhalation and delivers a bolus entrained from the reservoir early in the subsequent inspiration. Compared to conventional nasal cannulae, it has been shown to enable adequate oxygenation at reduced mean oxygen flow rates at 33%–50%[133–135] and improved exercise tolerance for the same oxygen usage.[136,137] Of note, the adjustment in the oxygen flow rate for OCDs or oxygen-conserving nasal cannulae cannot be predicted based on the prescribed or current continuous flow rate, nor are these consistent between different OCD models.[132,136,138–142]

Humidified nasal high-flow devices

Humidified nasal high-flow devices deliver heated, humidified oxygen (hNHF-O_2) via wide-bore nasal cannulae (high flow nasal cannulae [HFNC]), with delivered concentrations of up to 100% and flow rates of up to 70 L/min. These devices have primarily been used in hospitals, including for delivery of warm humidified air. The focus here is on their use in the home (Table S23 in the Supporting Information).

One RCT of 200 patients with COPD and chronic hypoxaemic respiratory failure showed a reduction in exacerbations in those using hNHF-O_2 at 20 L/min for an average of 6 h/day in addition to LTOT compared to those receiving LTOT alone at 12 months, with no difference in mortality between the groups.[143] Another study using at least overnight HFNC with daytime LTOT versus LTOT alone showed a reduction in the rate of and increased time to moderate-to-severe exacerbation in those with moderate-to-severe disease and daytime hypercapnia over 12 months.[144] Post-hoc analyses from a previous RCT suggested potential benefits of hNHF-O_2 in selected patients with severe COPD and chronic hypoxaemic respiratory failure with recurrent exacerbations.[145] Compared to LTOT, hNHF-O_2 was found to improve HRQoL in patients with COPD in two RCTs over 12 months, and in a randomized crossover trial after 6 weeks of therapy.[143,144,146] However, varying effects of hNHF-O_2 on dyspnoea were reported in studies of different trial designs and patient populations.[143,146–148] In terms of physiological effects on gas exchange and respiratory rates, hNHF-O_2 was found to achieve at least comparable oxygenation levels in comparison to LTOT,[146,147,149] reduced arterial partial pressure or transcutaneous carbon dioxide levels at rest, during exercise and overnight,[143,146,147,149–152] and reduced respiratory rate.[147,152]

Serious adverse events have not been reported with the domiciliary use of hNHF-O_2.[144,146]

Noise generated by hNHF-O_2 devices is a common complaint which may be addressed through the use of filters designed for noise reduction.[153] Factors reported by patients affecting adherence with domiciliary hNHF-O_2 in a RCT included perceived symptom and functional improvement, as well as perceived safety and familiarity with the device.[154]

Nevertheless, some patients reported preference for LTOT over hNHF-O_2 with respect to dyspnoea and device interface comfort.[152] Cost evaluations in a New Zealand healthcare setting showed cost-effectiveness and savings of up to $5535 NZD per patient-year associated with domiciliary hNHF-O_2 compared to usual care (including LTOT) in patients with severe COPD,[155] with similar cost-effectiveness reported in a European study.[156]

Recommendations for sources of domiciliary oxygen delivery.
New recommendations.

- Stationary concentrators are the recommended means of delivering oxygen in the home
- Portable oxygen concentrators can be used as sources of ambulatory oxygen therapy, with titration required to determine adequate oxygenation for the specific prescribed device
- Oxygen conserving devices (OCDs), including demand oxygen delivery systems and specialized oxygen-conserving nasal cannulae, can be used to achieve efficient oxygen use. Oxygen titration is needed to determine the appropriate settings for the individual with the specific OCD model
- Routine use of domiciliary hNHF-O_2 is not recommended, although it may be considered on a case-by-case basis, particularly in patients with COPD and frequent exacerbations.

SAFETY CONSIDERATIONS

There are potential safety concerns and risks associated with the use of domiciliary oxygen therapy. These include burns, fires, falls and other health consequences including the development of hypercapnia, as well as physical and psychological impacts on patients and caregivers (Tables S24 and S25 in the Supporting Information).

Fires and burns

There are limited published prospective safety studies on the risks of burns in patients using domiciliary oxygen therapy,[157,158] with the majority being reported in retrospective studies including case series and observational studies (Table S24 in the Supporting Information). Smoking by the patient or by others, is a major cause of burns and fires attributed to the use of domiciliary oxygen therapy, with other sources of ignition related to open flames such as during cooking.[159–161]

Burns may be facial or to other external parts of the body, but also include inhalation injuries in up to 39% of patients intubated for burns arising from domiciliary oxygen therapy.[162–165]

Deaths as a result of fires and burns in the setting of domiciliary oxygen therapy use have been reported, with a mean average hospital stay of 3.6 days in those with minor burns.[157,159–161,163,165–167]

Falls

There is little data regarding the risk of falls associated with using domiciliary oxygen therapy (Table S25 in the Supporting Information), although it is likely significant given the patient populations have high levels of frailty and multimorbidities.[168–170] This risk is of particular concern for patients who are cognitively, physically and/or visually impaired. An Australian observational study reported three cases of hospitalizations for falls associated with domiciliary oxygen tubing over 4 years of follow-up in 291 patients on LTOT, with one complicated by fracture.[171]

Hypercapnia

While worsening hypercapnia is a potential risk associated with domiciliary supplemental oxygen therapy, this does not appear to be of significant concern in most patients. Specific populations at risk of hypercapnic respiratory failure (including, but not limited to those with advanced suppurative lung diseases, chest wall deformities, severe obesity and overlapping sleep-disordered breathing), may require closer surveillance and consideration of specialized respiratory failure support.

Other health consequences

A single case–control study reported no differences in smell and taste for patients with COPD who were treated and not treated with domiciliary oxygen therapy.[172] Three experimental case–control studies explored the impact of supplemental oxygen on systemic redox balance in patients with COPD.[173–175] Two studies reported significant increases in proinflammatory or oxidative stress biomarkers using supplemental oxygen,[173,174] with administration of the antioxidant *N*-acetylcysteine in one study reversing erythrocyte protein oxidation.[174] The third study did not detect any difference in the oxidative stress biomarker isofuran between patients receiving and not receiving supplemental oxygen therapy.[175]

Physical and psychological impacts on patients and caregivers

Qualitative studies and surveys have explored the impact of using domiciliary oxygen therapy on patients and caregivers (Tables S5–S7, S16 and S25 in the Supporting Information). Stigma associated with domiciliary oxygen therapy is commonly reported by patients.[176–178] Some patients, who had used LTOT for more than 12 months, described poor self-image and sadness,[179] while other patients and caregivers reported increased social activity and perceived improvements in health status and capacity to participate in daily activities as a result of LTOT.[180] The use of domiciliary oxygen therapy also fails to meet patients' treatment expectations.[176,181,182]

Adverse impacts during daily living, as well as psychological and physical challenges, associated with using domiciliary oxygen therapy affect both patients and their caregivers.[181–185]

Recommendations regarding safety and risk considerations.

Safety factors are essential considerations in the prescription of domiciliary oxygen therapy. Education and verbal and written information should be provided to all patients, caregivers and any co-inhabitants.

Unchanged from previous Guideline.

- Oxygen should not be prescribed in patients who continue to smoke

New recommendations.

- Oxygen should not be used in close proximity to naked flames and other potential ignition sources including e-cigarettes
- Caregivers and others should be advised not to smoke in proximity to people using domiciliary oxygen therapy

- Adherence with smoking abstinence can be monitored with urinary cotinine, and/or carboxyhaemoglobin and carbon monoxide measurements
- Consideration should be given to withdrawing domiciliary oxygen therapy if the user continues to smoke, or if there are other concerns regarding fire risk
- Home visits by healthcare personnel may be an opportunity to provide additional information regarding fire and falls risks
- Potential psychosocial impact of domiciliary oxygen therapy should be considered and discussed with patients and caregivers as indicated
- Potential risk of hypercapnia should be considered on a case-by-case basis

ASSESSMENT AND SUPPORT FOR DOMICILIARY OXYGEN THERAPY

Assessment and support are key components for prescribing domiciliary oxygen therapy (Table S26 in the Supporting Information). In Australia and New Zealand, government-funded domiciliary oxygen therapy is generally prescribed by a respiratory physician, general physician, cardiologist or paediatrician, with additional approval from a specified respiratory physician required in some jurisdictions.[1] In selected states of Australia and in New Zealand, oncologists, geriatricians, palliative care specialists and nurse practitioners (respiratory) are listed as approved prescribers for domiciliary oxygen therapy.[1] For patients who reside in aged care facilities, domiciliary oxygen may be ordered by any registered medical officer.[1] The availability of a domiciliary oxygen therapy clinic, which may assist with appropriate assessment, prescription, support and follow-up of patients considered for domiciliary oxygen therapy varies across regions.[68,186–189]

Oxygenation status assessment

a. Resting hypoxaemia

Room air arterial blood gas (ABG) analysis at rest is required to ascertain the presence of severe resting hypoxaemia. After the patient is rested for 5–10 min breathing room air and an Allen's test is performed, an arterial sample using a small 25-gauge needle without anaesthetic should be obtained by a trained operator experienced in the technique. This approach will minimize pain and associated trauma, although patient preference should be considered.[1] Of note, using a topical anaesthetic has not been demonstrated to reduce pain associated with radial artery sampling.[190,191] While pulse oximeters are non-invasive and easily available, measurements of oxygen saturation do not provide an accurate estimation of PaO2, and should only be used for screening purposes.[192–195] In order to determine the optimal oxygen prescription to achieve SpO2 >90% or PaO2 >60 mm Hg, assessment with pulse oximetry or repeat ABG on supplemental oxygen may be performed. In patients with a background or at risk of hypercapnia, assessments using ABG on supplemental oxygen are required. Of note, the source of supplemental oxygen for the testing is preferably a stationary oxygen concentrator rather than wall oxygen which may lead to underestimation of the oxygen prescription.[196,197] While oximetry monitoring in the home setting has been evaluated in small studies for assessing both eligibility for LTOT and adequacy of oxygenation,[198–204] such an approach requires additional resources and it remains uncertain whether it leads to better patient health outcomes.

b. Nocturnal hypoxaemia

Overnight pulse oximetry can be used for assessment of nocturnal hypoxaemia, as well as for evaluation of nocturnal oxygen prescription in patients on LTOT.[205–210] Pulse oximeters with onboard memory capable of recording ≥8 h of data are suitable for this purpose, with data analysis providing estimates of average oxygenation overnight.[1] Nocturnal polysomnography (in laboratory or home-based) is required if there are concerns of sleep disordered breathing contributing to nocturnal hypoxaemia to allow appropriate management.

c. Exertional desaturation

Exercise tests are performed for assessment of exertional desaturation and prescription of supplemental oxygen during activities. The 6-min walk test (6MWT) is the most commonly used exercise test in clinical practice and has been extensively used in clinical research regarding ambulatory oxygen therapy, acknowledging some limitations in its performance.[211–213] Supplemental oxygen should be titrated during the test to determine the prescription of oxygen flow required to maintain SpO2 >88%.[214] To assess the effects of supplemental oxygen (including on dyspnoea severity and walk distance), a 6MWT using an air-filled cylinder is recommended to mitigate the known placebo effect.[215] While other exercise tests, such as shuttle walk tests, and assessments during domestic activities have been studied for evaluation of exertional desaturation,[216–218] their utility for prescribing domiciliary oxygen therapy is yet to be established.

d. Reassessment

Regular reassessments following initiation of domiciliary oxygen therapy are required in order to assess patients' ongoing oxygen needs over time.[189,219] Approximately 10%–58% of patients were no longer eligible for LTOT during re-evaluation at a range of follow-up duration between 1 month and 1 year.[220–222] While the optimal interval for reassessment is yet to be established, a period between 6 and

12 months is suitable for stable patients.[220,223] Patients with recent hospitalized acute exacerbation of the underlying disease for which LTOT has been prescribed may require reassessment within 90 days of discharge, which is similar to that for patients who are prescribed STOT.

Education and support provision for domiciliary oxygen therapy

Patient education has been shown to improve adherence with and appropriate use of domiciliary oxygen therapy, as well as providing an understanding of the associated safety precautions.[224–227] Both patients and clinicians express the need for education about domiciliary oxygen therapy.[177,181,182,228] Key information includes equipment types, how and when to use the prescribed oxygen therapy, setting appropriate treatment expectations and safety aspects with using oxygen therapy, as well as information about available support and follow-up. Patients and caregivers are increasingly accessing health information online. Of note, much of the online content about domiciliary oxygen therapy is of a low-to-moderate standard only, which is unsuitable for the general population.[229] Provision of regular support following initiation of domiciliary oxygen therapy, such as via telemonitoring and home visits, has been shown to improve mental-wellbeing and HRQoL and to reduce health care utilization, although additional resources are required.[230–233]

Recommendations for assessment and support for domiciliary oxygen therapy.
New recommendations.

- Appropriate assessment should be conducted for evaluation of different types of domiciliary oxygen therapy:
  - LTOT: ABG
  - NOT: Nocturnal pulse oximetry with ≥8-h recording time, with polysomnography being considered for those at risk of sleep disordered breathing
  - Ambulatory oxygen therapy: Exercise tests, with 6MWTs being preferred, as well as a dyspnoea score
  - STOT: If STOT is recommended for persistent hypoxaemia at hospital discharge, reassessment should be organized within 30–90 days post-discharge, as many patients will no longer require oxygen therapy
- Reassessment post-initiation of domiciliary oxygen therapy to determine ongoing need and adequacy of oxygen prescription is recommended at an interval of 6–12 months for stable patients and following hospitalization for acute exacerbation of the underlying disease
- Patient and caregiver education is an essential component of the prescription of domiciliary oxygen therapy.

AREAS FOR FUTURE RESEARCH

As highlighted in the literature review for this Guideline, limited evidence exists to guide the clinical use of domiciliary oxygen therapy in adults. There is an urgent need to establish medium and long-term treatment effects (mortality, exercise capacity, HRQoL, symptoms, psychological well-being, biomarkers of oxidative stress and inflammation) and cost-effectiveness of different types of oxygen therapy in patients with different chronic respiratory diseases who are optimally managed with contemporary medical therapies.

With technological advances, the role of home monitoring through the use of wearable devices and newer oxygen delivery devices such as hNHF-O_2 should be evaluated. Cross-disciplinary collaborations are needed to allow the development of novel, portable and ergonomic oxygen delivery devices that meet high oxygen requirements. There is also a need to understand the current model of care and gaps in assessment and provision of domiciliary oxygen therapy and ongoing care in Australia and New Zealand.

ACKNOWLEDGEMENTS

We would like to thank John Blakey and Michael Elizalde for their contribution to document development. Open access publishing facilitated by The University of Melbourne, as part of the Wiley - The University of Melbourne agreement via the Council of Australian University Librarians.

CONFLICT OF INTEREST STATEMENT

No funding was received to support the development of this Guideline. CFM reports appointments as Clinical Advisor, Domiciliary Oxygen Program, State-Wide Equipment Program, VIC; Chair of the COPD National Program Lung Foundation Australia; Member of the COPD-X Guidelines Committee Lung Foundation Australia; Member of the TGA Ventilator Expert Group; Member of Clinical Executive Austin Health; and Medical Director of the Institute for Breathing and Sleep. CFM received grants from NHMRC, MRFF, GSK Investigator-sponsored Scheme, Institute for Breathing and Sleep and The Prince Charles Hospital Foundation. CFM is the Editor in Chief of *Respiratory Medicine Today* and Deputy Editor for *Respirology* and was excluded from all editorial decision-making related to the acceptance and publication of this article. CB received Travel Grants from TSANZ, Fisher and Paykel Healthcare, the St George Institute of Health and reports volunteer roles in TSANZ Victorian Branch, TSANZ Respiratory Nurse SIG, TSANZ Professional Standards Committee, ASA Education

Committee and ASA Sleep Nurse Chair. BRM is Clinical Advisor, Domiciliary Oxygen Program, State-Wide Equipment Program, VIC. NS received grants from NHMRC, MRFF, Cancer Council Australia, Industry grant from Fisher& Paykel Healthcare, Philanthropic grants from Windermere Foundation, Lung Foundation Australia, Lord Mayor's Foundation Melbourne, PACT Grant-in-Aid. NS is Board Director TSANZ, Board Director Victorian Doctor's Program, European Respiratory Society Co-Chair Guidelines Committee. NS received consulting fees from The Limbic and Orchard Consulting; speaker's fees from GSK, Boehringer Ingelheim, Astra Zeneca, Fisher Paykel Healthcare, Health Ed; travel support from Chiesi and Boehringer Ingelheim; and equipment for investigator-initiated clinical trials from Fisher Paykel Healthcare. NS is an Advisory Board member for *Respirology* and was excluded from all editorial decision-making related to the acceptance and publication of this article. LT reports consulting fees from Boehringer Ingelheim, and speaker fees from Erbe. ElektromedizinGmbH. YHK reports non-financial support from Air Liquide Healthcare outside the submitted work; grants from NHMRC, MRFF, Austin Medical Research Foundation, Lung Foundation Australia, TSANZ and RACP; YHK is Board Director TSANZ; guidelines methodologist ATS; Associate Editor European Respiratory Journal, and Clinical Advisor, Domiciliary Oxygen Program, State-Wide Equipment Program, VIC. JS, SA, HD and MM have no conflicts of interest to declare.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

ORCID

Christine F. McDonald https://orcid.org/0000-0001-6481-3391
Natasha Smallwood https://orcid.org/0000-0002-3403-3586
Lauren Troy https://orcid.org/0000-0002-7426-336X
Yet Hong Khor https://orcid.org/0000-0002-5434-9342

LINKED CONTENT

This publication is linked to a related article. To view this article, visit https://doi.org/10.1111/resp.14794

REFERENCES

1. McDonald CF, Whyte K, Jenkins S, Serginson J, Frith P. Clinical Practice Guideline on adult domiciliary oxygen therapy: executive summary from the Thoracic Society of Australia and New Zealand. Respirology. 2016;21:76–8.
2. Guyatt G, Oxman AD, Akl EA, Kunz R, Vist G, Brozek J, et al. GRADE guidelines: 1. Introduction-GRADE evidence profiles and summary of findings tables. J Clin Epidemiol. 2011;64:383–94.
3. Continuous or nocturnal oxygen therapy in hypoxemic chronic obstructive lung disease: a clinical trial. Nocturnal Oxygen Therapy Trial Group. Ann Intern Med. 1980;93:391–8.
4. Long term domiciliary oxygen therapy in chronic hypoxic cor pulmonale complicating chronic bronchitis and emphysema. Report of the Medical Research Council Working Party. Lancet. 1981;1:681–6.
5. Ahmadi Z, Sundh J, Bornefalk-Hermansson A, Ekstrom M. Long-term oxygen therapy 24 vs 15 h/day and mortality in chronic obstructive pulmonary disease. PLoS One. 2016;11:e0163293.
6. Abdelghany MF, Elkady SM, Elkarn AF, Aly MG. Clinical outcome of 1-year long-term oxygen therapy in patients with chronic obstructive pulmonary disease. Egyptian J Chest Dis Tuberc. 2018;67:208–13.
7. Crockett AJ, Moss JR, Cranston JM, Alpers JH. The effects of home oxygen therapy on hospital admission rates in chronic obstructive airways disease. Monaldi Arch Chest Dis. 1993;48:445–6.
8. Sundh J, Ahmadi Z, Ekstrom M. Daily duration of long-term oxygen therapy and risk of hospitalization in oxygen-dependent COPD patients. Int J Chron Obstruct Pulmon Dis. 2018;13:2623–8.
9. Heaton RK, Grant I, McSweeny AJ, Adams KM, Petty TL. Psychologic effects of continuous and nocturnal oxygen therapy in hypoxemic chronic obstructive pulmonary disease. Arch Intern Med. 1983;143:1941–7.
10. Okubadejo AA, Paul EA, Jones PW, Wedzicha JA. Does long-term oxygen therapy affect quality of life in patients with chronic obstructive pulmonary disease and severe hypoxaemia? Eur Respir J. 1996;9:2335–9.
11. Eaton T, Lewis C, Young P, Kennedy Y, Garrett JE, Kolbe J. Long-term oxygen therapy improves health-related quality of life. Respir Med. 2004;98:285–93.
12. Gorecka D, Gorzelak K, Sliwinski P, Tobiasz M, Zielinski J. Effect of long-term oxygen therapy on survival in patients with chronic obstructive pulmonary disease with moderate hypoxaemia. Thorax. 1997;52:674–9.
13. Ringbaek TJ, Fabricius P, Lange P. The effect of home oxygen therapy on hospitalization in moderate hypoxaemic COPD. Chron Respir Dis. 2005;2:107–8.
14. Albert RK, Au DH, Blackford AL, Casaburi R, Cooper JA, Criner GJ, et al. A randomized trial of long-term oxygen for COPD with moderate desaturation. N Engl J Med. 2016;375:1617–27.
15. Clark AL, Johnson M, Fairhurst C, Torgerson D, Cockayne S, Rodgers S, et al. Does home oxygen therapy (HOT) in addition to standard care reduce disease severity and improve symptoms in people with chronic heart failure? A randomised trial of home oxygen therapy for patients with chronic heart failure. Health Technol Assess. 2015;19:1–120.
16. Ulrich S, Saxer S, Hasler ED, Schwarz EI, Schneider SR, Furian M, et al. Effect of domiciliary oxygen therapy on exercise capacity and quality of life in patients with pulmonary arterial or chronic thromboembolic pulmonary hypertension: a randomised, placebo-controlled trial. Eur Respir J. 2019;54:1900276.
17. Gustafson T, Franklin KA, Midgren B, Pehrsson K, Ranstam J, Strom K. Survival of patients with kyphoscoliosis receiving mechanical ventilation or oxygen at home. Chest. 2006;130:1828–33.
18. Troy LK, Young IH, Lau EMT, Wong KKH, Yee BJ, Torzillo PJ, et al. Nocturnal hypoxaemia is associated with adverse outcomes in interstitial lung disease. Respirology. 2019;24:996–1004.
19. Fletcher EC, Donner CF, Midgren B, Zielinski J, Levi-Valensi P, Braghiroli A, et al. Survival in COPD patients with a daytime PaO_2 greater than 60 mm Hg with and without nocturnal oxyhemoglobin desaturation. Chest. 1992;101:649–55.
20. Frangolias DD, Wilcox PG. Predictability of oxygen desaturation during sleep in patients with cystic fibrosis: clinical, spirometric, and exercise parameters. Chest. 2001;119:434–41.
21. Khor YH, Ng Y, Sweeney D, Ryerson CJ. Nocturnal hypoxaemia in interstitial lung disease: a systematic review. Thorax. 2021;76:1200–8.
22. Lacasse Y, Series F, Corbeil F, Baltzan M, Paradis B, Simao P, et al. Randomized trial of nocturnal oxygen in chronic obstructive pulmonary disease. N Engl J Med. 2020;383:1129–38.
23. Chaouat A, Weitzenblum E, Kessler R, Charpentier C, Enrhart M, Schott R, et al. A randomized trial of nocturnal oxygen therapy in chronic obstructive pulmonary disease patients. Eur Respir J. 1999;14:1002–8.

24. Fletcher EC, Luckett RA, Goodnight-White S, Miller CC, Qian W, Costarangos-Galarza C. A double-blind trial of nocturnal supplemental oxygen for sleep desaturation in patients with chronic obstructive pulmonary disease and a daytime PaO_2 above 60 mm Hg. Am Rev Respir Dis. 1992;145:1070–6.
25. Sampol G, Sagales MT, Roca A, de la Calzada MD, Bofill JM, Morell F. Nasal continuous positive airway pressure with supplemental oxygen in coexistent sleep apnoea-hypopnoea syndrome and severe chronic obstructive pulmonary disease. Eur Respir J. 1996;9:111–6.
26. Bordier P, Orazio S, Hofmann P, Robert F, Bourenane G. Short- and long-term effects of nocturnal oxygen therapy on sleep apnea in chronic heart failure. Sleep Breath. 2015;19:159–68.
27. Sasayama S, Izumi T, Matsuzaki M, Matsumori A, Asanoi H, Momomura S, et al. Improvement of quality of life with nocturnal oxygen therapy in heart failure patients with central sleep apnea. Circ J. 2009;73:1255–62.
28. Sasayama S, Izumi T, Seino Y, Ueshima K, Asanoi H, Group C-HS. Effects of nocturnal oxygen therapy on outcome measures in patients with chronic heart failure and Cheyne–Stokes respiration. Circ J. 2006;70:1–7.
29. Toyama T, Seki R, Kasama S, Isobe N, Sakurai S, Adachi H, et al. Effectiveness of nocturnal home oxygen therapy to improve exercise capacity, cardiac function and cardiac sympathetic nerve activity in patients with chronic heart failure and central sleep apnea. Circ J. 2009;73:299–304.
30. Seino Y, Imai H, Nakamoto T, Araki Y, Sasayama S, Chf HOT. Clinical efficacy and cost-benefit analysis of nocturnal home oxygen therapy in patients with central sleep apnea caused by chronic heart failure. Circ J. 2007;71:1738–43.
31. Javaheri S, Ahmed M, Parker TJ, Brown CR. Effects of nasal O_2 on sleep-related disordered breathing in ambulatory patients with stable heart failure. Sleep. 1999;22:1101–6.
32. Sakakibara M, Sakata Y, Usui K, Hayama Y, Kanda S, Wada N, et al. Effectiveness of short-term treatment with nocturnal oxygen therapy for central sleep apnea in patients with congestive heart failure. J Cardiol. 2005;46:53–61.
33. Suzuki J, Ishihara T, Sakurai K, Inagaki H, Kawabata M, Hachiya H, et al. Oxygen therapy prevents ventricular arrhythmias in patients with congestive heart failure and sleep apnea. Circ J. 2006;70:1142–7.
34. Arzt M, Schulz M, Wensel R, Montalvan S, Blumberg FC, Riegger GA, et al. Nocturnal continuous positive airway pressure improves ventilatory efficiency during exercise in patients with chronic heart failure. Chest. 2005;127:794–802.
35. Murase K, Ono K, Yoneda T, Iguchi M, Yokomatsu T, Mizoguchi T, et al. Adaptive servoventilation versus oxygen therapy for sleep disordered breathing in patients with heart failure: a randomised trial. Open Heart. 2016;3:e000366.
36. Gottlieb DJ, Punjabi NM, Mehra R, Patel SR, Quan SF, Babineau DC, et al. CPAP versus oxygen in obstructive sleep apnea. N Engl J Med. 2014;370:2276–85.
37. Lewis EF, Wang R, Punjabi N, Gottlieb DJ, Quan SF, Bhatt DL, et al. Impact of continuous positive airway pressure and oxygen on health status in patients with coronary heart disease, cardiovascular risk factors, and obstructive sleep apnea: a Heart Biomarker Evaluation in Apnea Treatment (HEARTBEAT) analysis. Am Heart J. 2017;189:59–67.
38. Lim W, Bardwell WA, Loredo JS, Kim EJ, Ancoli-Israel S, Morgan EE, et al. Neuropsychological effects of 2-week continuous positive airway pressure treatment and supplemental oxygen in patients with obstructive sleep apnea: a randomized placebo-controlled study. J Clin Sleep Med. 2007;3:380–6.
39. Loredo JS, Ancoli-Israel S, Kim EJ, Lim WJ, Dimsdale JE. Effect of continuous positive airway pressure versus supplemental oxygen on sleep quality in obstructive sleep apnea: a placebo-CPAP-controlled study. Sleep. 2006;29:564–71.
40. Mostafavi A, Aliabadi L, Sadeghniyat K, Tabatabaei SAH. Comparison of the efficacy of continuous positive airway pressure and oxygen therapy in increasing heart rate variability in patients with obstructive sleep apnea. Iran Heart J. 2017;18(4):34–41.
41. Bardwell WA, Norman D, Ancoli-Israel S, Loredo JS, Lowery A, Lim W, et al. Effects of 2-week nocturnal oxygen supplementation and continuous positive airway pressure treatment on psychological symptoms in patients with obstructive sleep apnea: a randomized placebo-controlled study. Behav Sleep Med. 2007;5:21–38.
42. Spier S, Rivlin J, Hughes D, Levison H. The effect of oxygen on sleep, blood gases, and ventilation in cystic fibrosis. Am Rev Respir Dis. 1984;129:712–8.
43. Milross MA, Piper AJ, Norman M, Becker HF, Willson GN, Grunstein RR, et al. Low-flow oxygen and bilevel ventilatory support: effects on ventilation during sleep in cystic fibrosis. Am J Respir Crit Care Med. 2001;163:129–34.
44. Elphick HE, Mallory G. Oxygen therapy for cystic fibrosis. Cochrane Database Syst Rev. 2013;2013:CD003884.
45. Milross MA, Piper AJ, Dwyer TJ, Wong K, Bell SC, Bye PTP. Non-invasive ventilation versus oxygen therapy in cystic fibrosis: a 12-month randomized trial. Respirology. 2019;24:1191–7.
46. Lim RK, Humphreys C, Morisset J, Holland AE, Johannson KA, Collaborators OD. Oxygen in patients with fibrotic interstitial lung disease: an international Delphi survey. Eur Respir J. 2019;54:1900421.
47. Vazquez JC, Perez-Padilla R. Effect of oxygen on sleep and breathing in patients with interstitial lung disease at moderate altitude. Respiration. 2001;68:584–9.
48. Sadaka AS, Montgomery AJ, Mourad SM, Polkey MI, Hopkinson NS. Exercise response to oxygen supplementation is not associated with survival in hypoxemic patients with obstructive lung disease. Int J Chron Obstruct Pulmon Dis. 2018;13:1607–12.
49. Visca D, Mori L, Tsipouri V, Fleming S, Firouzi A, Bonini M, et al. Effect of ambulatory oxygen on quality of life for patients with fibrotic lung disease (AmbOx): a prospective, open-label, mixed-method, crossover randomised controlled trial. Lancet Respir Med. 2018;6:759–70.
50. Abernethy AP, McDonald CF, Frith PA, Clark K, Herndon JE 2nd, Marcello J, et al. Effect of palliative oxygen versus room air in relief of breathlessness in patients with refractory dyspnoea: a double-blind, randomised controlled trial. Lancet. 2010;376:784–93.
51. Campbell ML, Yarandi H, Dove-Medows E. Oxygen is nonbeneficial for most patients who are near death. J Pain Symptom Manage. 2013;45:517–23.
52. Philip J, Gold M, Milner A, Di Iulio J, Miller B, Spruyt O. A randomized, double-blind, crossover trial of the effect of oxygen on dyspnea in patients with advanced cancer. J Pain Symptom Manage. 2006;32:541–50.
53. Clemens KE, Quednau I, Klaschik E. Use of oxygen and opioids in the palliation of dyspnoea in hypoxic and non-hypoxic palliative care patients: a prospective study. Support Care Cancer. 2009;17:367–77.
54. Currow DC, Agar M, Smith J, Abernethy AP. Does palliative home oxygen improve dyspnoea? A consecutive cohort study. Palliat Med. 2009;23:309–16.
55. Igarashi H, Fukushi M, Nago N. Oxygen use and survival in patients with advanced cancer and low oxygen saturation in home care: a preliminary retrospective cohort study. BMC Palliat Care. 2020;19:3.
56. Collier A, Breaden K, Phillips JL, Agar M, Litster C, Currow DC. Caregivers' perspectives on the use of long-term oxygen therapy for the treatment of refractory breathlessness: a qualitative study. J Pain Symptom Manage. 2017;53:33–9.
57. Kelly CA, O'Brien MR. Difficult decisions: an interpretative phenomenological analysis study of healthcare professionals' perceptions of oxygen therapy in palliative care. Palliat Med. 2015;29:950–8.
58. Smallwood N, Currow D, Booth S, Spathis A, Irving L, Philip J. Approaches to palliative oxygen therapy in chronic obstructive pulmonary disease: a multi-national survey of specialists. Intern Med J. 2019;49:252–6.
59. Breaden K, Phillips J, Agar M, Grbich C, Abernethy AP, Currow DC. The clinical and social dimensions of prescribing palliative home oxygen for refractory dyspnea. J Palliat Med. 2013;16:268–73.

60. Piquet J, Chavaillon JM, David P, Martin F, Blanchon F, Roche N. High-risk patients following hospitalisation for an acute exacerbation of COPD. Eur Respir J. 2013;42:946–55.
61. Banerjee J, Canamar CP, Voyageur C, Tangpraphaphorn S, Lemus A, Coffey CJ, et al. Mortality and readmission rates among patients with COVID-19 after discharge from acute care setting with supplemental oxygen. JAMA Netw Open. 2021;4:e213990.
62. Eaton TE, Grey C, Garrett JE. An evaluation of short-term oxygen therapy: the prescription of oxygen to patients with chronic lung disease hypoxic at discharge from hospital. Respir Med. 2001;95:582–7.
63. Andersson I, Johansson K, Larsson S, Pehrsson K. Long-term oxygen therapy and quality of life in elderly patients hospitalised due to severe exacerbation of COPD. A 1 year follow-up study. Respir Med. 2002; 96:944–9.
64. Levin K, Borg B, Miller B, Kee K, Dabscheck E. Characteristics of patients who progress from bridging to long-term oxygen therapy. Intern Med J. 2018;48:1376–81.
65. Soumagne T, Maltais F, Corbeil F, Paradis B, Baltzan M, Simão P, et al. Short-term oxygen therapy outcomes in COPD. Int J Chron Obstruct Pulmon Dis. 2022;17:1685–93.
66. Khor YH, Wong R, McDonald CF. Post-hospitalization short-term oxygen therapy: use of a clinical management pathway and long-term follow-up. Respir Care. 2019;64:272–8.
67. Spece LJ, Epler EM, Duan K, Donovan LM, Griffith MF, LaBedz S, et al. Reassessment of home oxygen prescription after hospitalization for COPD: a potential target for de-implementation. Ann Am Thorac Soc. 2021;18(3):426–32.
68. Chaney JC, Jones K, Grathwohl K, Olivier KN. Implementation of an oxygen therapy clinic to manage users of long-term oxygen therapy. Chest. 2002;122:1661–7.
69. Wiener RS, Ouellette DR, Diamond E, Fan VS, Maurer JR, Mularski RA, et al. An official American Thoracic Society/American College of Chest Physicians Policy Statement. The choosing wisely top five list in adult pulmonary medicine. Chest. 2014;145:1383–91.
70. Petty TL, Casaburi R. Recommendations of the Fifth Oxygen Consensus Conference. Writing and Organizing Committees. Respir Care. 2000;45:957–61.
71. Alison JA, McKeough ZJ, Leung RWM, Holland AE, Hill K, Morris NR, et al. Oxygen compared to air during exercise training in COPD with exercise-induced desaturation. Eur Respir J. 2019;53: 1802429.
72. Garrod R, Paul EA, Wedzicha JA. Supplemental oxygen during pulmonary rehabilitation in patients with COPD with exercise hypoxaemia. Thorax. 2000;55:539–43.
73. Ringbaek T, Martinez G, Lange P. The long-term effect of ambulatory oxygen in normoxaemic COPD patients: a randomised study. Chron Respir Dis. 2013;10:77–84.
74. Spielmanns M, Fuchs-Bergsma C, Winkler A, Fox G, Krüger S, Baum K. Effects of oxygen supply during training on subjects with COPD who are normoxemic at rest and during exercise: a blinded randomized controlled trial. Respir Care. 2015;60:540–8.
75. Peña JB, Ávila Valencia JC, Assis JK, Gutiérrez HH, Córdoba VB. Benefits of pulmonary rehabilitation in patients with COPD with use and without the use of supplemental oxygen during exercise. Curr Respir Med Rev. 2019;15:281–8.
76. Padmanaban V, Collins C, Lound A, Lee C, Mallia P, Elkin SL. The role of ambulatory oxygen in improving the effectiveness of pulmonary rehabilitation for patient with chronic obstructive pulmonary disease—single blinded randomised trial. Thorax. 2019;219 (74):A8.
77. Rooyackers JM, Dekhuijzen PN, Van Herwaarden CL, Folgering HT. Training with supplemental oxygen in patients with COPD and hypoxaemia at peak exercise. Eur Respir J. 1997;10:1278–84.
78. Chihara Y, Tsuboi T, Sumi K, Sato A. Effectiveness of high-flow nasal cannula on pulmonary rehabilitation in subjects with chronic respiratory failure. Respir Investig. 2022;60:658–66.
79. Dyer F, Callaghan J, Cheema K, Bott J. Ambulatory oxygen improves the effectiveness of pulmonary rehabilitation in selected patients with chronic obstructive pulmonary disease. Chron Respir Dis. 2012;9: 83–91.
80. Akero A, Edvardsen A, Christensen CC, Owe JO, Ryg M, Skjonsberg OH. COPD and air travel: oxygen equipment and preflight titration of supplemental oxygen. Chest. 2011;140:84–90.
81. Berg BW, Dillard TA, Rajagopal KR, Mehm WJ. Oxygen supplementation during air travel in patients with chronic obstructive lung disease. Chest. 1992;101:638–41.
82. Fischer R, Wanka ER, Einhaeupl F, Voll K, Schiffl H, Lang SM, et al. Comparison of portable oxygen concentrators in a simulated airplane environment. Respir Med. 2013;107:147–9.
83. Kelly PT, Swanney MP, Stanton JD, Frampton C, Peters MJ, Beckert LE. Supplemental oxygen effect on hypoxemia at moderate altitude in patients with COPD. Aviat Space Environ Med. 2009;80: 815–9.
84. Campbell CD, Smyth MW, Brown L, Kelly E. Air travel for subjects receiving long-term oxygen therapy. Respir Care. 2018;63:326–31.
85. Coker RK, Armstrong A, Church AC, Holmes S, Naylor J, Pike K, et al. BTS Clinical Statement on air travel for passengers with respiratory disease. Thorax. 2022;77:329–50.
86. Robson AG, Lenney J, Innes JA. Using laboratory measurements to predict in-flight desaturation in respiratory patients: are current guidelines appropriate? Respir Med. 2008;102:1592–7.
87. Bradi AC, Faughnan ME, Stanbrook MB, Deschenes-Leek E, Chapman KR. Predicting the need for supplemental oxygen during airline flight in patients with chronic pulmonary disease: a comparison of predictive equations and altitude simulation. Can Respir J. 2009;16:119–24.
88. Dillard TA, Berg BW, Rajagopal KR, Dooley JW, Mehm WJ. Hypoxemia during air travel in patients with chronic obstructive pulmonary disease. Ann Intern Med. 1989;111:362–7.
89. Kelly PT, Swanney MP, Seccombe LM, Frampton C, Peters MJ, Beckert L. Air travel hypoxemia vs. the hypoxia inhalation test in passengers with COPD. Chest. 2008;133:920–6.
90. Akero A, Christensen CC, Edvardsen A, Ryg M, Skjonsberg OH. Pulse oximetry in the preflight evaluation of patients with chronic obstructive pulmonary disease. Aviat Space Environ Med. 2008;79:518–24.
91. Miyagi S, Matsumoto T, Kisyaba T, Tamaki H. A trial of home oxygen for acute asthma attacks for the prevention of asthmatic death. Allergol Int. 2005;54:31–4.
92. Cohen AS, Burns B, Goadsby PJ. High-flow oxygen for treatment of cluster headache: a randomized trial. JAMA. 2009;302:2451–7.
93. Dirkx THT, Haane DYP, Koehler PJ. Oxygen treatment for cluster headache attacks at different flow rates: a double-blind, randomized, crossover study. J Headache Pain. 2018;19:94.
94. Singhal AB, Maas MB, Goldstein JN, Mills BB, Chen DW, Ayata C, et al. High-flow oxygen therapy for treatment of acute migraine: a randomized crossover trial. Cephalalgia. 2017;37:730–6.
95. Mawet J, Valade D, Vigan M, Laouenan C, Roos C. Oxygen delivered by a high flow concentrator for the treatment of medication-overuse headache: a prospective open-labeled pilot feasibility study. Cephalalgia Rep. 2018;1:1.
96. Cirio S, Nava S. Pilot study of a new device to titrate oxygen flow in hypoxic patients on long-term oxygen therapy. Respir Care. 2011;56: 429–34.
97. Rice KL, Schmidt MF, Buan JS, Lebahn F, Schwarzock TK. AccuO_2 oximetry-driven oxygen-conserving device versus fixed-dose oxygen devices in stable COPD patients. Respir Care. 2011;56:1901–5.
98. Lellouche F, L'Her E, Bouchard PA, Brouillard C, Maltais F. Automatic oxygen titration during walking in subjects with COPD: a randomized crossover controlled study. Respir Care. 2016;61:1456–64.
99. Sanchez-Morillo D, Munoz-Zara P, Lara-Dona A, Leon-Jimenez A. Automated home oxygen delivery for patients with COPD and respiratory failure: a new approach. Sensors (Basel). 2020;20:20.
100. Schneeberger T, Jarosch I, Leitl D, Gloeckl R, Hitzl W, Dennis CJ, et al. Automatic oxygen titration versus constant oxygen flow rates during walking in COPD: a randomised controlled, double-blind, crossover trial. Thorax. 2023;78:326–34.

101. Moghal MEU, Goburdhun AR, Morrell M, Dickinson R, Simonds AK. A novel smartphone based auto-titrating oxygen system reduces intermittent hypoxia during activities of daily living in patients on long-term oxygen therapy. Am J Respir Crit Care Med. 2017;195:A7709.
102. Phillips GD, Harrison NK, Cummin AR, Ward J, Shenoy VS, Newey V, et al. New method for measuring compliance with long term oxygen treatment. BMJ. 1994;308:1544–5.
103. Lin SK, Kuna ST, Bogen DK. A novel device for measuring long-term oxygen therapy adherence: a preliminary validation. Respir Care. 2006;51:266–71.
104. Lin SK, Bogen DK, Kuna ST. Validation of a novel device to objectively measure adherence to long-term oxygen therapy. Int J Chron Obstruct Pulmon Dis. 2008;3:435–42.
105. Hirche TO, Born T, Jungblut S, Sczepanski B, Kenn K, Kohnlein T, et al. Oxygen generation by combined electrolysis and fuel-cell technology: clinical use in COPD patients requiring long time oxygen therapy. Eur J Med Res. 2008;13:451–8.
106. Katsenos S, Charisis A, Daskalopoulos G, Constantopoulos SH, Vassiliou MP. Long-term oxygen therapy in chronic obstructive pulmonary disease: the use of concentrators and liquid oxygen systems in north-western Greece. Respiration. 2006;73:777–82.
107. Su CL, Lee CN, Chen HC, Feng LP, Lin HW, Chiang LL. Comparison of domiciliary oxygen using liquid oxygen and concentrator in northern Taiwan. J Formos Med Assoc. 2014;113:23–32.
108. Mussa CC, Tonyan L, Chen YF, Vines D. Perceived satisfaction with long-term oxygen delivery devices affects perceived mobility and quality of life of oxygen-dependent individuals with COPD. Respir Care. 2018;63:11–9.
109. Kacmarek RM. Delivery systems for long-term oxygen therapy. Respir Care. 2000;45:84–92.
110. Anonymous. Home controls of a sample of 2,414 oxygen concentrators. Sous-Commission Technique ANTADIR. Eur Respir J. 1991;4: 227–31.
111. Cullen DL, Koss JA. Oxygen tubing lengths and output flows: implications for patient care. Chron Respir Dis. 2005;2:193–7.
112. Aguiar C, Davidson J, Carvalho AK, Iamonti VC, Cortopassi F, Nascimento OA, et al. Tubing length for long-term oxygen therapy. Respir Care. 2015;60:179–82.
113. Bongard JP, Pahud C, De Haller R. Insufficient oxygen concentration obtained at domiciliary controls of eighteen concentrators. Eur Respir J. 1989;2:280–2.
114. Chatburn RL, Williams TJ. Performance comparison of 4 portable oxygen concentrators. Respir Care. 2010;55:433–42.
115. Blakeman TC, Rodriquez D Jr, Britton TJ, Johannigman JA, Petro MC, Branson RD. Evaluation of oxygen concentrators and chemical oxygen generators at altitude and temperature extremes. Mil Med. 2016;181:160–8.
116. Bunel V, Shoukri A, Choin F, Roblin S, Smith C, Similowski T, et al. Bench evaluation of four portable oxygen concentrators under different conditions representing altitudes of 2438, 4200, and 8000 m. High Alt Med Biol. 2016;17:370–4.
117. Martin DC. Contemporary portable oxygen concentrators and diverse breathing behaviours—a bench comparison. BMC Pulm Med. 2019; 19:217.
118. Nasilowski J, Przybylowski T, Zielinski J, Chazan R. Comparing supplementary oxygen benefits from a portable oxygen concentrator and a liquid oxygen portable device during a walk test in COPD patients on long-term oxygen therapy. Respir Med. 2008;102:1021–5.
119. Subramaniam V, Cheema T, Carlin B, McCoy R. Evaluation of portable oxygen concentrators during exercise at pulmonary rehabilitation. Chest. 2008;134:100002s.
120. Strickland SL, Hogan TM, Hogan RG, Sohal HS, McKenzie WN, Petroski GF. A randomized multi-arm repeated-measures prospective study of several modalities of portable oxygen delivery during assessment of functional exercise capacity. Respir Care. 2009;54:344–9.
121. Couillard A, Veale D, Foret D, Melloni B, Sauder P, Muir JF. A randomised cross-over clinical testing of portable oxygen concentrators in patients with COPD. European Respiratory Society Annual Congress, Amsterdam, The Netherlands, September 24–28. 2011; 38: 384s [P2166].
122. Leblanc CJ, Lavallee LG, King JA, Taylor-Sussex RE, Woolnough A, McKim DA. A comparative study of 3 portable oxygen concentrators during a 6-minute walk test in patients with chronic lung disease. Respir Care. 2013;58:1598–605.
123. Smith B, Labiszewski N, Carson K, Lawton K, Kotal L, Liversidge C. Portable oxygen cylinders versus battery powered concentrators for COPD: a randomized crossover study. Respirology. 2013;18:26.
124. Lawton K, Kotal L, Nguyen H, Jurisevic M, Segal L, Liversidge C, et al. Quality of life among participants of a multi-centre RCT comparing portable oxygen concentrators to portable oxygen cylinders. Respirology. 2014;19:115.
125. Khor YH, McDonald CF, Hazard A, Symons K, Westall G, Glaspole I, et al. Portable oxygen concentrators versus oxygen cylinder during walking in interstitial lung disease: a randomized crossover trial. Respirology. 2017;22:1598–603.
126. Graziano L, Asciutti D, Savi D, Rivolta M, Turinese I, Schiavetto S, et al. Efficacy of a portable oxygen concentrator in the promotion of physical activity and the quality of life in a group of patients with cystic fibrosis: pilot study. J Cyst Fibros. 2019;18:S165.
127. Hoffman M, Cox S, Burge A, McDonald C, Corte T, Chambers D, et al. Portable oxygen concentrator for delivery of ambulatory oxygen in interstitial lung disease: a crossover trial. Respirology. 2019;24:168.
128. Moretta P, Molino A, Martucci M, Fuschillo S, De Felice A, Guida P, et al. Subject preferences and psychological implications of portable oxygen concentrator versus compressed oxygen cylinder in chronic lung disease. Respir Care. 2021;66:33–40.
129. Crisafulli E, Costi S, De Blasio F, Biscione G, Americi F, Penza S, et al. Effects of a walking aid in COPD patients receiving oxygen therapy. Chest. 2007;131:1068–74.
130. Krauza ML, McCarroll ML, Pohle-Krauza RJ, Volsko TA, Tessmer KA. The effects of different carrying positions of portable oxygen containers (pocs) on energy expenditure in healthy subjects. Chest. 2009;136:126S-a.
131. Pohle-Krauza RJ, McCarroll ML, Pannikottu K, Latta TN, DiNuoscio DR, Volsko TA, et al. Body mass index moderates the effects of portable oxygen transport modality on 6-minute walk distance in patients with COPD. J Mol Signal. 2014;34:62–8.
132. Braun SR, Spratt G, Scott GC, Ellersieck M. Comparison of six oxygen delivery systems for COPD patients at rest and during exercise. Chest. 1992;102:694–8.
133. Claiborne RA, Paynter DE, Dutt AK, Rowlands JW. Evaluation of the use of an oxygen conservation device in long-term oxygen therapy. Am Rev Respir Dis. 1987;136:1095–8.
134. Moore-Gillon JC, George RJ, Geddes DM. An oxygen conserving nasal cannula. Thorax. 1985;40:817–9.
135. Domingo C, Roig J, Coll R, Klamburg J, Izquierdo J, Ruiz-Manzano J, et al. Evaluation of the use of three different devices for nocturnal oxygen therapy in COPD patients. Respiration. 1996;63:230–5.
136. Gloeckl R, Heinzelmann I, Matthaei M, Seeberg S, Damisch T, Jerrentrup A, et al. Benefits of an oxygen reservoir cannula versus a conventional nasal cannula during exercise in hypoxemic COPD patients: a crossover trial. Respiration. 2014;88:399–405.
137. Edvardsen A, Jarosch I, Grongstad A, Wiegand L, Gloeckl R, Kenn K, et al. A randomized cross-over trial on the direct effects of oxygen supplementation therapy using different devices on cycle endurance in hypoxemic patients with Interstitial Lung Disease. PLoS One. 2018; 13:e0209069.
138. Fuhrman C, Chouaid C, Herigault R, Housset B, Adnot S. Comparison of four demand oxygen delivery systems at rest and during exercise for chronic obstructive pulmonary disease. Respir Med. 2004;98: 938–44.
139. Gloeckl R, Jarosch I, Schneeberger T, Fiedler C, Lausen M, Weingaertner J, et al. Comparison of supplemental oxygen delivery by continuous versus demand based flow systems in hypoxemic COPD patients—a randomized, single-blinded cross-over study. Respir Med. 2019;156:26–32.

140. Hagarty EM, Skorodin MS, Langbein WE, Hultman CI, Jessen JA, Maki KC. Comparison of three oxygen delivery systems during exercise in hypoxemic patients with chronic obstructive pulmonary disease. Am J Respir Crit Care Med. 1997;155:893–8.
141. Roberts CM, Bell J, Wedzicha JA. Comparison of the efficacy of a demand oxygen delivery system with continuous low flow oxygen in subjects with stable COPD and severe oxygen desaturation on walking. Thorax. 1996;51:831–4.
142. Zhou S, Chatburn RL. Effect of the anatomic reservoir on low-flow oxygen delivery via nasal cannula: constant flow versus pulse flow with portable oxygen concentrator. Respir Care. 2014;59:1199–209.
143. Storgaard LH, Hockey HU, Laursen BS, Weinreich UM. Long-term effects of oxygen-enriched high-flow nasal cannula treatment in COPD patients with chronic hypoxemic respiratory failure. Int J Chron Obstruct Pulmon Dis. 2018;13:1195–205.
144. Nagata K, Horie T, Chohnabayashi N, Jinta T, Tsugitomi R, Shiraki A, et al. Home high-flow nasal cannula oxygen therapy for stable hypercapnic COPD: a randomized clinical trial. Am J Respir Crit Care Med. 2022;206:1326–35.
145. Weinreich UM. Domiciliary high-flow treatment in patients with COPD and chronic hypoxic failure: in whom can we reduce exacerbations and hospitalizations? PLoS One. 2020;14:e0227221.
146. Nagata K, Kikuchi T, Horie T, Shiraki A, Kitajima T, Kadowaki T, et al. Domiciliary high-flow nasal cannula oxygen therapy for patients with stable hypercapnic chronic obstructive pulmonary disease. A multicenter randomized crossover trial. Ann Am Thorac Soc. 2018;15:432–9.
147. Spoletini G, Watson R, Lim WY, Pollard K, Etherington C, Clifton IJ, et al. Nasal high-flow therapy as an adjunct to exercise in patients with cystic fibrosis: a pilot feasibility trial. J Cyst Fibros. 2021;20:e46–52.
148. Suzuki A, Ando M, Kimura T, Kataoka K, Yokoyama T, Shiroshita E, et al. The impact of high-flow nasal cannula oxygen therapy on exercise capacity in fibrotic interstitial lung disease: a proof-of-concept randomized controlled crossover trial. BMC Pulm Med. 2020;20:51.
149. Vogelsinger H, Halank M, Braun S, Wilkens H, Geiser T, Ott S, et al. Efficacy and safety of nasal high-flow oxygen in COPD patients. BMC Pulm Med. 2017;17:143.
150. Nilius G, Domanski U, Franke K-j, Ruehle K-H, Schneider H. Nasal high flow oxygen therapy attenuates nocturnal hypoventilation in COPD patients with Hypercapnic respiratory failure. B55 NON-INVASIVE VENTILATION. American Thoracic Society, 2013; A3102-A.
151. Storgaard LH, Hockey HU, Weinreich UM. Development in PaCO(2) over 12 months in patients with COPD with persistent hypercapnic respiratory failure treated with high-flow nasal cannula-post-hoc analysis from a randomised controlled trial. BMJ Open Respir Res. 2020;7:7.
152. Fraser JF, Spooner AJ, Dunster KR, Anstey CM, Corley A. Nasal high flow oxygen therapy in patients with COPD reduces respiratory rate and tissue carbon dioxide while increasing tidal and end-expiratory lung volumes: a randomised crossover trial. Thorax. 2016;71:759–61.
153. Kubo T, Nakajima H, Shimoda R, Seo T, Kanno Y, Kondo T, et al. Noise exposure from high-flow nasal cannula oxygen therapy: a bench study on noise reduction. Respir Care. 2018;63:267–73.
154. Storgaard LH, Weinreich UM, Laursen BS. COPD patients' experience of long-term domestic oxygen-enriched nasal high flow treatment: a qualitative study. COPD. 2020;17:175–83.
155. Milne RJ, Hockey HU, Garrett J. Hospital cost Savings for Sequential COPD patients receiving domiciliary nasal high flow therapy. Int J Chron Obstruct Pulmon Dis. 2022;17:1311–22.
156. Sørensen SS, Storgaard LH, Weinreich UM. Cost-effectiveness of domiciliary high flow nasal cannula treatment in COPD patients with chronic respiratory failure. Clin Outcomes Res. 2021;13:553–64.
157. Tanash HA, Huss F, Ekstrom M. The risk of burn injury during long-term oxygen therapy: a 17-year longitudinal national study in Sweden. Int J Chron Obstruct Pulmon Dis. 2015;10:2479–84.
158. Tanash HA, Ringbaek T, Huss F, Ekstrom M. Burn injury during long-term oxygen therapy in Denmark and Sweden: the potential role of smoking. Int J Chron Obstruct Pulmon Dis. 2017;12:12–197.
159. Chang TT, Lipinski CA, Sherman HF. A hazard of home oxygen therapy. J Burn Care Rehabil. 2001;22:71–4. discussion 0–1.
160. Muehlberger T, Smith MA, Wong L. Domiciliary oxygen and smoking: an explosive combination. Burns. 1998;24:658–60.
161. Yoon JS, Khoo KH, Puthumana JS, Pérez Rivera LR, Keller PR, Lagziel T, et al. Outcomes of patients with Burns associated with home oxygen therapy: an institutional retrospective review. J Burn Care Res. 2022;43:1024–31.
162. Amani H, Lozano DD, Blome-Eberwein S. Brother, have you got a light? Assessing the need for intubation in patients sustaining burn injury secondary to home oxygen therapy. J Burn Care Res. 2012;33:e280–5.
163. Carlos WG, Baker MS, McPherson KA, Bosslet GT, Sood R, Torke AM. Smoking-related home oxygen burn injuries: continued cause for alarm. Respiration. 2016;91:151–5.
164. Edelman DA, Maleyko-Jacobs S, White MT, Lucas CE, Ledgerwood AM. Smoking and home oxygen therapy—a preventable public health hazard. J Burn Care Res. 2008;29:119–22.
165. Daniels M, Stromps JP, Heitzmann W, Schiefer J, Fuchs PC, Seyhan H. Nexobrid treatment for burn injuries in patients with chronic obstructive pulmonary disease and home oxygen therapy. J Burn Care Res. 2023;44:693–7.
166. Sharma G, Meena R, Goodwin JS, Zhang W, Kuo YF, Duarte AG. Burn injury associated with home oxygen use in patients with chronic obstructive pulmonary disease. Mayo Clin Proc. 2015;90:492–9.
167. Singer KE, Harvey JA, Heh V, Dale EL. Mortality from Burns sustained on home oxygen therapy exceeds predicted mortality. J Burn Care Res. 2020;41:976–80.
168. Harrison AC, Robinson JF, Tu L, McDonald CF, Khor YH. Multidisciplinary care and prognosis in patients with COPD and interstitial lung disease prescribed long-term oxygen therapy. Respir Care. 2022;67:667–75.
169. Hernandez C, Aibar J, de Batlle J, Gomez-Cabrero D, Soler N, Duran-Tauleria E, et al. Assessment of health status and program performance in patients on long-term oxygen therapy. Respir Med. 2015;109:500–9.
170. Oliveira CC, Annoni R, Lee AL, McGinley J, Irving LB, Denehy L. Falls prevalence and risk factors in people with chronic obstructive pulmonary disease: a systematic review. Respir Med. 2021;176:106284.
171. Semasinghe Bandaralage SP, Denniss AR, Syed M, Sriram KB. Long-term oxygen therapy-related adverse outcomes resulting in hospitalisation: 3-year experience of an Australian metropolitan health service. Intern Med J. 2019;49:1435–7.
172. Dewan NA, Bell CW, Moore J, Anderson B, Kirchain W, O'Donohue WJ Jr. Smell and taste function in subjects with chronic obstructive pulmonary disease. Effect of long-term oxygen via nasal cannulas. Chest. 1990;97:595–9.
173. Carpagnano GE, Kharitonov SA, Foschino-Barbaro MP, Resta O, Gramiccioni E, Barnes PJ. Supplementary oxygen in healthy subjects and those with COPD increases oxidative stress and airway inflammation. Thorax. 2004;59:1016–9.
174. Foschino Barbaro MP, Serviddio G, Resta O, Rollo T, Tamborra R, Elisiana Carpagnano G, et al. Oxygen therapy at low flow causes oxidative stress in chronic obstructive pulmonary disease: prevention by N-acetyl cysteine. Free Radic Res. 2005;39:1111–8.
175. Stulce JM, Biddle C, Vacchiano C. Low-flow domiciliary oxygen as a mechanism of ongoing oxidative stress. Respir Care. 2019;64:1387–91.
176. Breaden K, Collier A, Litster C, Allcroft P, Currow DC, Phillips JL. Stigma and the in(visible) perspectives and expectations of home oxygen therapy among people with chronic breathlessness syndrome: a qualitative study. Palliat Med. 2019;33:82–90.
177. Khor YH, Goh NSL, McDonald CF, Holland AE. Oxygen therapy for interstitial lung disease: physicians' perceptions and experiences. Ann Am Thorac Soc. 2017;14:1772–8.
178. Karki A, Morante J, Cervellione KL, Ullah T, Patel V, Fein AM. Oxygen indications and utilization in a diverse, urban community setting. J Cardiopulm Rehabil Prev. 2020;40:438–40.
179. Bueno GH, Campos CJG, Turato ER, Paschoal IA, Valladão LS, Baltieri L, et al. Experiences in elderly people with chronic obstructive pulmonary disease in relation to the use of long-term home oxygen therapy: a qualitative study about feelings attributed to therapy. BMC Pulm Med. 2022;22:96.

180. Goldbart J, Yohannes AM, Woolrych R, Caton S. 'It is not going to change his life but it has picked him up': a qualitative study of perspectives on long term oxygen therapy for people with chronic obstructive pulmonary disease. Health Qual Life Outcomes. 2013; 11:124.
181. Cleries X, Sola M, Chiner E, Escarrabill J, Collaborative Group of SEPAR 2014/2015 Year of the Chronic Patient and Home Respiratory Therapy for Evaluating the patient Experience. Defining patient and caregivers' experience of home oxygen therapy. Arch Bronconeumol. 2016;52:131–7.
182. Khor YH, Goh NSL, McDonald CF, Holland AE. Oxygen therapy for interstitial lung disease. A mismatch between patient expectations and experiences. Ann Am Thorac Soc. 2017;14:888–95.
183. Kampelmacher MJ, Van Kesteren RG, Alsbach GPJ, Melissant CF, Wynne HJ, Douze JMC, et al. Characteristics and complaints of patients prescribed long-term oxygen therapy in The Netherlands. Respir Med. 1998;92:70–5.
184. Ring L, Danielson E. Patients' experiences of long-term oxygen therapy. J Adv Nurs. 1997;26:337–44.
185. Graney BA, Wamboldt FS, Baird S, Churney T, Fier K, Korn M, et al. Informal caregivers experience of supplemental oxygen in pulmonary fibrosis. Health Qual Life Outcomes. 2017;15:133.
186. Montner P, Sergent M, Case E, Douglas M, Griego E, Martinez F, et al. TQI in the Albuquerque veterans affairs medical Center's long-term oxygen therapy program. Jt Comm J Qual Improv. 1998;24:203–11.
187. O'Donnell C, Davis P, McDonnell T. Oxygen therapy in Ireland: a Nationwide review of delivery, monitoring and cost implications. Ir Med J. 2019;112:933.
188. Turner AM, Sen S, Steeley C, Khan Y, Sweeney P, Richards Y, et al. Evaluation of oxygen prescription in relation to hospital admission rate in patients with chronic obstructive pulmonary disease. BMC Pulm Med. 2014;14:127.
189. McKeon JL, Saunders NA, Murree-Allen K. Domiciliary oxygen: rationalization of supply in the hunter region from 1982-1986. Med J Australia. 1987;146:73–8.
190. Tran NQ, Pretto JJ, Worsnop CJ. A randomized controlled trial of the effectiveness of topical amethocaine in reducing pain during arterial puncture. Chest. 2002;122:1357–60.
191. Aaron SD, Vandemheen KL, Naftel SA, Lewis MJ, Rodger MA. Topical tetracaine prior to arterial puncture: a randomized, placebo-controlled clinical trial. Respir Med. 2003;97:1195–9.
192. Carlin BW, Clausen JL, Ries AL. The use of cutaneous oximetry in the prescription of long-term oxygen therapy. Chest. 1988;94:239–41.
193. Ekkernkamp E, Welte L, Schmoor C, Huttmann SE, Dreher M, Windisch W, et al. Spot check analysis of gas exchange: invasive versus noninvasive methods. Respiration. 2015;89:294–303.
194. Roberts CM, Bugler JR, Melchor R, Hetzel MR, Spiro SG. Value of pulse oximetry in screening for long-term oxygen therapy requirement. Eur Respir J. 1993;6:559–62.
195. Roberts CM, Franklin J, O'Neill A, Roberts RP, Ide J, Hanley ML, et al. Screening patients in general practice with COPD for long-term domiciliary oxygen requirement using pulse oximetry. Respir Med. 1998;92:1265–8.
196. Bolton CE, Annandale JA, Ebden P. Comparison of an oxygen concentrator and wall oxygen in the assessment of patients undergoing long term oxygen therapy assessment. Chron Respir Dis. 2006;3:49–51.
197. Dheda K, Lim K, Ollivere B, Leftley J, Lampe FC, Salisbury A, et al. Assessments for oxygen therapy in COPD: are we under correcting arterial oxygen tensions? Eur Respir J. 2004;24:954–7.
198. Morrison D, Skwarski KM, MacNee W. The adequacy of oxygenation in patients with hypoxic chronic obstructive pulmonary disease treated with long-term domiciliary oxygen. Respir Med. 1997; 91:287–91.
199. Pilling J, Cutaia M. Ambulatory oximetry monitoring in patients with severe COPD: a preliminary study. Chest. 1999;116:314–21.
200. Abdulla J, Godtfredsen N, Pisinger C, Wennike P, Tonnesen P. Adequacy of oxygenation in a group of Danish patients with COPD on long-term oxygen therapy. Monaldi Arch Chest Dis. 2000;55:279–82.
201. Fussell KM, Ayo DS, Branca P, Rogers JT, Rodriguez M, Light RW. Assessing need for long-term oxygen therapy: a comparison of conventional evaluation and measures of ambulatory oximetry monitoring. Respir Care. 2003;48:115–9.
202. Zhu Z, Barnette RK, Fussell KM, Michael Rodriguez R, Canonico A, Light RW. Continuous oxygen monitoring—a better way to prescribe long-term oxygen therapy. Respir Med. 2005;99:1386–92.
203. Faria I, Gaspar C, Zamith M, Matias I, das Neves RC, Rodrigues F, et al. TELEMOLD project: oximetry and exercise telemonitoring to improve long-term oxygen therapy. Telemed J E Health. 2014;20: 626–32.
204. Rodrigues MP, Vissoci CM, Rosa SP, Negreiros SBC. 24-hour hypoxia and pulmonary hypertension in patients with idiopathic pulmonary fibrosis. Open Respir Med J. 2017;11:11–6.
205. Ayache M, Strohl KP. High interrater reliability of overnight pulse oximetry interpretation among inexperienced physicians using a structured template. J Clin Sleep Med. 2018;14:541–8.
206. Carroll N, Walshaw MJ, Evans CC, Hind CR. Nocturnal oxygen desaturation in patients using long-term oxygen therapy for chronic airflow limitation. Respir Med. 1990;84:199–201.
207. Nisbet M, Eaton T, Lewis C, Fergusson W, Kolbe J. Overnight prescription of oxygen in long term oxygen therapy: time to reconsider the guidelines? Thorax. 2006;61:779–82.
208. Plywaczewski R, Sliwinski P, Nowinski A, Kaminski D, Zielinski J. Incidence of nocturnal desaturation while breathing oxygen in COPD patients undergoing long-term oxygen therapy. Chest. 2000;117: 679–83.
209. Samolski D, Tarrega J, Anton A, Mayos M, Marti S, Farrero E, et al. Sleep hypoventilation due to increased nocturnal oxygen flow in hypercapnic COPD patients. Respirology. 2010;15:283–8.
210. Tarrega J, Guell R, Anton A, Mayos M, Farre A, Jerez FR, et al. Are daytime arterial blood gases a good reflection of nighttime gas exchange in patients on long-term oxygen therapy? Respir Care. 2002; 47:882–6.
211. Chatterjee AB, Rissmiller RW, Meade K, Paladenech C, Conforti J, Adair NE, et al. Reproducibility of the 6-minute walk test for ambulatory oxygen prescription. Respiration. 2010;79:121–7.
212. Sanchez-Morillo D, Lara-Dona A, Priego-Torres B, Morales-Gonzalez M, Montoro-Ballesteros F, Leon-Jimenez A. Portable oxygen therapy: is the 6-minute walking test overestimating the actual oxygen needs? J Clin Med. 2020;9:1–12.
213. Carone M, Patessio A, Appendini L, Purro A, Czernicka E, Zanaboni S, et al. Comparison of invasive and noninvasive saturation monitoring in prescribing oxygen during exercise in COPD patients. Eur Respir J. 1997;10:446–51.
214. Lourido-Cebreiro T, Gonzalez-Barcala FJ, Alvarez-Dobano JM, Pereiro-Brea T, Abelleira-Paris R, Valdes L. Need for portable oxygen titration during 6-minute walk tests. Arch Bronconeumol. 2019;55: 539–40.
215. Lock SH, Paul EA, Rudd RM, Wedzicha JA. Portable oxygen therapy: assessment and usage. Respir Med. 1991;85:407–12.
216. Lewko A, Marshall J, Garrod R. Ambulatory oxygen therapy assessment: a comparative study of incremental shuttle and 6-minute walking tests. Physiotherapy. 2007;93:261–6.
217. Sandland CJ, Morgan MD, Singh SJ. Detecting oxygen desaturation in patients with COPD: incremental versus endurance shuttle walking. Respir Med. 2008;102:1148–52.
218. Sant'Anna T, Donaria L, Hernandes NA, Furlanetto KC, Barbosa DS, Gosselink R, et al. Oxygen desaturation in daily life and during a laboratory-based protocol of activities of daily living in COPD: is there relationship? Lung. 2018;196:19–26.
219. Lourido-Cebreiro T, Gonzalez-Barcala FJ, Rabade C, Abelleira-Paris R, Pereiro-Brea T, Valdes L. Progress after the withdrawal of home oxygen therapy. The profile of patients requiring reintroduction. Arch Bronconeumol. 2019;55:663–5.
220. Gorecka D, Sliwinski P, Zielinski J. Adherence to entry criteria and one year experience of long-term oxygen therapy in Poland. Eur Respir J. 1992;5:848–52.

221. Loutsios C, Logan G, Deeming C, Powrie D, Davison A. One blood gas is not enough to assess a patient for ltot-how to kiss goodbye to circa 10 million in England. Thorax. 2010;65:A171.
222. Oba Y, Salzman GA, Willsie SK. Reevaluation of continuous oxygen therapy after initial prescription in patients with chronic obstructive pulmonary disease. Respir Care. 2000;45:401–6.
223. Cottrell JJ, Openbrier D, Lave JR, Paul C, Garland JL. Home oxygen therapy. A comparison of 2- vs 6-month patient reevaluation. Chest. 1995;107:358–61.
224. Atis S, Tutluoglu B, Bugdayci R. Characteristics and compliance of patients receiving long-term oxygen therapy (LTOT) in Turkey. Monaldi Arch Chest Dis. 2001;56:105–9.
225. Peckham DG, McGibbon K, Tonkinson J, Plimbley G, Pantin C. Improvement in patient compliance with long-term oxygen therapy following formal assessment with training. Respir Med. 1998;92:1203–6.
226. Pepin JL, Barjhoux CE, Deschaux C, Brambilla C. Long-term oxygen therapy at home. Compliance with medical prescription and effective use of therapy. ANTADIR Working Group on Oxygen Therapy. Association Nationale de Traitement a Domicile des Insuffisants Respiratories. Chest. 1996;109:1144–50.
227. Dogan U, Ovayolu N. The effects of health education given by nurses to COPD patients on the daily oxygen concentrator usage time. Adv Respir Med. 2017;85:15–21.
228. Jacobs SS, Lindell KO, Collins EG, Garvey CM, Hernandez C, McLaughlin S, et al. Patient perceptions of the adequacy of supplemental oxygen therapy. Results of the American Thoracic Society Nursing Assembly Oxygen Working Group Survey. Ann Am Thorac Soc. 2018;15:24–32.
229. Ang HL, Tan HH, Logie KM, McDonald CF, Khor YH. Online patient information on domiciliary oxygen therapy: an evaluation of quality, suitability, reliability, readability, and content. Chest. 2022;161:483–91.
230. Burioka N, Yamamoto A, Morimoto M, Yamasaki A, Hirayama Y, Takata M. Health-related quality of life in patients on home oxygen therapy with telemonitoring. Yonago Acta Med. 2020;63:132–4.
231. Clini E, Vitacca M, Foglio K, Simoni P, Ambrosino N. Long-term home care programmes may reduce hospital admissions in COPD with chronic hypercapnia. Eur Respir J. 1996;9:1605–10.
232. Prieto-Centurion V, Basu S, Bracken NE, Casaburi R, Gallardo R, Gonzalez V, et al. Comparative effectiveness of a PEer-led supplemental oxygen InfoLine for patients and CAregivers (PELICAN). Am J Respir Crit Care Med. 2018;197:1009–17.
233. Yu YL, Zheng XS, Han XX, Sun MJ. The application value of continuous nursing for home oxygen therapy of patients in the stable phase of chronic obstructive pulmonary disease. Eur Rev Med Pharmacol Sci. 2017;21:67–72.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: McDonald CF, Serginson J, AlShareef S, Buchan C, Davies H, Miller BR, et al. Thoracic Society of Australia and New Zealand clinical practice guideline on adult home oxygen therapy. Respirology. 2024. https://doi.org/10.1111/resp.14793